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FORECASTING MV-22 AERIAL REFUELING TRAINING MISSIONS FOR 2D MARINE AIRCRAFT WING

by

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December 1999

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This thesis quantifies the impact that fielding the MV-22 within the 2nd Marine Aircraft Wing (MAW) will have on its KC-130 squadrons. This impact arises from the MV-22's capability to receive fuel in-flight (aerial refuel). Since the CH-46E and CH-53D could not aerial refuel, their pilots did not have a need to conduct aerial refueling training, and thus

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This research quantifies the future increase in demand in terms of aerial refueling missions and offers recommendations to reduce it. For 2nd MAW, this increase will peak in FY12 with 164 missions being "scheduled."

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FORECASTING MV-22 AERIAL REFUELING TRAINING MISSIONS FOR 2D MARINE AIRCRAFT WING

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This research quantifies the future increase in demand in terms of aerial refueling missions and offers recommendations to reduce it. For 2nd MAW, this increase will peak in FY12 with 164 missions being "scheduled."

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LIST OF ACRONYMS

AAAV	Advanced Amphibious Assault Vehicle
AAW	Antiair Warfare
ACE	Aviation Combat Element
AFB	Air Force Base
AG	Aerial Gunnery
AMARC	Aerospace Maintenance and Regeneration Center
ANSQ	Advance Night Systems Qualification
APW	Aviation Weapons Systems Requirements Branch
AR	Aerial Refueling
ARG	Amphibious Ready Group
ATC	Air Traffic Control
BLT	Battalion Landing Team
CAL	Confined Area Landing
CAS	Close Air Support
CE	Command Element
CINCUSUSACOM	Commander in Chief United States Atlantic Command
CINCUSUSPACOM	Commander in Chief United States Pacific Command
CONUS	Continental United States
CQ	Carrier Qualification
CRP	Combat Readiness Percentage
CSSE	Combat Service Support Element
DAS	Deep Air Support
DASC	Direct Air Support Center
DASC (A)	Direct Air Support Center (Airborne)
DM	Defensive Measures
EA	Electronic Attack
EW	Electronic Warfare
EP	Electronic Protection
ES	Electronic Warfare Support
EXT	External
FAC	Forward Air Controller
FAC (A)	Forward Air Controller (Airborne)
FSSG	Force Service Support Group
FOB	Forward Operating Base
FORM	Formation
GCE	Ground Combat Element

HAR	Helicopter Aerial Refueling
HMH	Marine Heavy Helicopter Squadron
HMLA	Marine Light Attack Helicopter Squadron
HMM	Marine Medium Helicopter Squadron
HMM (Rein)	Marine Medium Helicopter (Reinforced) Squadron
JTF	Joint Task Force
LAAD	Low Altitude Air Defense
MACG	Marine Air Control Group
MACS	Marine Air Control Squadron
MAG	Marine Air Group
MAGTF	Marine Air Ground Task Force
MALS	Marine Aviation Logistic Squadron
MAW	Marine Air Wing
MARDIV	Marine Division
MAWTS-1	Marine Aviation Weapons and Tactics Squadron-1
MCAS	Marine Corps Air Station
MCCDC	Marine Corps Combat Development Command
MEF	Marine Expeditionary Force
METL	Mission Essential Task List
MEU	Marine Expeditionary Unit
MEU (SOC)	Marine Expeditionary Unit (Special Operations Capable)
MLFDS	Medium Lift Fuel Dispensing System
MOTT	Muti-Operational Test Team
MSSG	MEU Service Support Group
MTACS	Marine Tactical Air Command Squadron
MWCS	Marine Wing Communication Squadron
MWSG	Marine Wing Support Group
MWSS	Marine Wing Support Squadron
NATOPS	Naval Air Training And Operating Procedures Standardization
NAVFLIR	Naval Aircraft Flight Report
OAAW	Offensive Antiair Warfare
OAS	Offensive Air Support
OMFTS	Operational Maneuver Warfare From the Sea
OPCON	Operational Control
RGR	Rapid Ground Refueling
SAR	Search and Rescue
STOM	Ship-To-Objective Maneuver

TAC (A)	Tactical Air Controller (Airborne)
TACC	Tactical Air Command Center
TERF	Terrain Flight
TRAP	Tactical Recovery of Aircraft and Personnel
VIE	Tilt-Rotor Insertion/Extraction
VLAT	Tilt-Rotor Low Altitude Tactics
VMA	Marine Attack Squadron
VMAQ	Marine Tactical Electronic Warfare Squadron
VMFA	Marine Fighter Attack Squadron
VMFA(AW)	Marine All-Weather Fighter Attack Squadron
VMGR	Marine Aerial Refueler Transport Squadron
VMM	Marine Medium Vertical Tilt-Rotor Squadron
VMMT	Marine Medium Vertical Tilt-Rotor Training Squadron
VMU	Marine Unmanned Aerial Vehicle Squadron
UAV	Unmanned Aerial Vehicle

I. INTRODUCTION

A. PURPOSE

This research develops a model to predict the number of MV-22 aerial refueling training missions within the 2d Marine Aircraft Wing (MAW) from FY00 to FY14. These numbers are important for two reasons: (1) to present U.S. Marine Planners additional information that may be useful in determining future procurement requirements for the KC-130J; (2) to provide essential information to help the active duty Marine Air Wings (MAWs) determine the impact the MV-22 will have on KC-130 Squadrons.

B. BACKGROUND

As the Marine Corps enters into the 21st century, improving technology and the ever-changing geopolitical structure calls for revolutionary changes to our traditional amphibious doctrine. This call has been answered by the Marine Corps' strategic vision statement, "Operational Maneuver From The Sea" (OMFTS). Essential to OMFTS is the ability to move units from ships lying over the horizon to objectives far from the shore. One of the Marine Corps solutions to this problem is the MV-22 "Osprey," the first tilt-rotor aircraft to be fielded anywhere in the world.

The MV-22 was designed as the "medium-lift" replacement for the Marine Corps aging CH-46E and CH-53D helicopters. Presently there are 231 CH-46Es and 45 CH-53Ds in service with the Marine Corps. [Ref. 1] In FY00, the Marine Corps will begin "fielding" the MV-22. [Ref. 2] This process will conclude in

FY14, with a total strength of approximately 360 MV-22s (337 factoring in an annual "peacetime" attrition rate of 1%). [Ref. 3]

Besides the increase in speed and range that the MV-22 offers, there is one capability that the U.S. Marine Corps CH-46Es and CH-53Ds do not possess. This is the capability to conduct aerial refueling. Aerial refueling is the process where one aircraft refuels another aircraft while in flight. There are several "tanker" platforms within the armed services capable of conducting this mission (i.e. KC-10, KC-135); one belongs to the Marine Corps. This aircraft is known as the KC-130 "Hercules." Because of the limited Marine Corps "tanker" fleet, the introduction of a new group of aerial refueling (receive only) capable aircraft could present a problem.

The problem is best described through the traditional economic model of "Supply vs. Demand." This scenario will likely be one where the "Supply" (Marine Corps aircraft capable of "giving" fuel in flight) is held constant and the "Demand" (Marine Corps aircraft capable of receiving fuel in flight) increases as a result of fielding the MV-22s. This scenario implies that the Marine Corps will encounter an impending shortage based on the fixed number of "Tanker" aircraft.

C. RESEARCH QUESTIONS

1. Primary

The primary research question that this thesis will address is: How many aerial refueling training missions should the 2d Marine Aircraft Wing (MAW) plan to conduct to support MV-22 pilot proficiency requirements?

2. Subsidiary

The subsidiary research questions are:

- Will there be a difference between the amount of aerial refueling training missions required to support a "Core" MV-22 Squadron and a "Reinforced" MV-22 Squadron?

- How can the Marine Corps reduce the impact of the increased aerial refueling training requirements on the KC-130 community?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

1. Scope

This research will analyze historical data from several 2d Marine Aircraft Wing, Marine Medium Helicopter (HMM) and Marine Heavy Helicopter (HMH) squadrons. The data measures the quantity of aerial refueling training missions scheduled and flown to support the CH-53E pilot training requirements. Data from the HMM squadrons will be derived from the period they were reinforced (HMM (REIN)). This data will be used to develop a model to forecast the MV-22 aerial refueling training requirements as it is fielded from FY00 to FY14.

The scope of this study will include:

- Predicting the aerial refueling missions required by MV-22 Squadrons to maintain the proficiency of their pilots for the time period between Fiscal Years 2000 and 2014.

- Recommending alternative fuel delivery aircraft (tankers) to support the MV-22 aerial refueling training requirements.

- Reviewing the aerial refueling training requirements for the AV-8B, EA-6B, F/A-18A/B/C &D, CH-53E and the MV-22.

The scope will not include:

- Predicting the fuel required to fulfill MV-22 aerial refueling training requirements.
- Predicting the costs to support MV-22 Aerial refueling Requirements.
- Predicting the percentage increase in yearly KC-130 flight hours.
- Developing doctrine for using MV-22 and/or KC-130 aircraft.

2. Limitations

This thesis estimates the amount of aerial refueling training missions required to support MV-22 squadrons, specifically within the 2d Marine Aircraft Wing (MAW). The findings for 2d MAW may or may not be applicable to the other two active-duty MAWs. Differences in the number of organizational elements and deployment cycles may cause these results to vary. Therefore, without further research, the author can not conclude that the results from this model are applicable to the other MAWs.

The "HMM (Rein)" data for the model was based on data acquired from three of the six HMM squadrons within 2d MAW. This limitation reflects limited time for "on-site" research and the squadrons' operational commitments. Additionally, most squadrons only maintain past flight schedules and NAVFLIRs for the previous two years. Therefore, only one year's worth of composite HMM data could be collected from the squadrons currently not deployed.

3. Assumptions

Based on this research and the author's previous experience as a Marine aviator with over 2800 flight hours, the following assumptions were applied to the forecast model:

- Aerial refueling training missions are a factor of pilot proficiency requirements.
- The MV-22 pilot's aerial refueling training proficiency requirements are the same as a CH-53E pilot's requirements.
- The "Table of Organization (T/O)" for the number of pilots in a MV-22 squadron will be the same as a CH-46E squadron.
- The MV-22 Squadrons training and deployment cycle will mirror that of a CH-46E Squadron.

E. METHODOLOGY

The methodology used in this thesis research includes the following: (1) a literature search of books, magazine articles, CD-ROM systems, and other library information resources, (2) a site visit to MCAS New River to research past Marine Medium Helicopter Squadron (HMM) and Marine Heavy Helicopter Squadron (HMH) operational, maintenance and administrative records, (3) interviews with personnel from APW, MOTT, MAWTS-1, MAG-26 and MAG-29, (4) Developing a model for the aerial refueling training requirements of a standard MV-22 Squadron (VMM) and a Reinforced MV-22 Squadron (VMM(REIN)) based on data collected in Step 2, (5) analyzing the results.

F. ORGANIZATION OF RESEARCH

Chapter I. Introduction. This chapter describes the purpose of the thesis and states the primary and subsidiary research question.

Chapter II. Marine Aviation. This chapter summarizes the background information necessary to understand Marine Aviation's missions and organizational structure.

Chapter III. The Future and Marine Aviation. This chapter reviews the Marine Corps strategic vision "Operational Maneuver Warfare From The Sea (OMFTS)" and the role of the MV-22 "Osprey."

Chapter IV. Forecasting Aerial Refueling Training Missions for the MV-22. This chapter describes how the model used to estimate the future MV-22 aerial refueling training missions was developed and presents its forecasted results.

Chapter V. Conclusions and Recommendations. This chapter will provide the conclusions and recommendations to the author's primary and subsidiary research questions, as well as suggest areas for further study.

II. MARINE AVIATION

A. INTRODUCTION

This chapter provides the reader with the background information necessary to understand the importance of Marine Aviation in supporting the Marine Air Ground Task Force (MAGTF). It focuses on explaining the roles and missions of the different units that comprise a Marine Aircraft Wing (MAW).

B. MARINE AIR GROUND TASK FORCE

The uniqueness of the United States Marine Corps is epitomized through the Marine Air Ground Task Force (MAGTF). Expeditionary in nature, the MAGTF can rapidly deploy by either sea or air and provide the naval or joint commander a force capable of operating as [Ref. 4]:

- The landing force of an amphibious task organization.
- A land force in sustained operations ashore.
- The landward portion of a naval force conducting military operations other than war.

When compared to the other Armed Forces of the United States, neither the Navy, Army nor Air Force possesses the MAGTF's capability to provide a completely indigenous "combined arms" force. "Combined arms" can be defined as, "The tactics, techniques, and procedures employed by a force to integrate firepower and mobility to produce a desired effect upon the enemy." [Ref. 5]

The MAGTF's unique combined arms capability is facilitated by its organizational structure. Regardless of it size, each MAGTF will train and deploy with the same organizational structure. Due to this continuity in structure, a MAGTF may increase or decrease in size with little to no reorganization. This flexibility is an essential characteristic for a successful military organization.

1. Structure

The following four elements are common to all MAGTFs.

a. Command Element

The Command Element (CE) is the Headquarters element of each MAGTF. It is task organized to provide the command and control capabilities that are necessary for effective planning, execution and assessment of operations across the six warfighting functions[1]. [Ref. 6]

b. Ground Combat Element

The Ground Combat Element (GCE) is task organized to conduct ground operations, project combat power, and contribute to battlespace dominance in supporting the MAGTF's mission. It is formed around an infantry organization that is reinforced as necessary with artillery, reconnaissance, assault amphibian, armor and engineer forces. The GCE is one of two elements of the MAGTF specifically designed for combat operations. [Ref. 7]

[1] The six-warfighting functions are: command and control, intelligence, maneuver, fires, logistics, and force protection.

c. *Aviation Combat Element*

The Aviation Combat Element (ACE) is task organized to conduct air operations, project combat power, and contribute to battlespace dominance in support of the MAGTF's mission by performing some or all of the six functions of Marine Aviation. It is formed around an aviation headquarters with air control agencies and combat, combat support, and combat service support units. The ACE may be employed from ships or forward expeditionary land bases and can readily transition between sea bases and land bases without losing capability. The ACE is one of two MAGTF elements specifically designed for combat operations. [Ref. 8]

d. *Combat Service Support Element*

The Combat Service Support Element (CSSE) is task organized to provide the full range of tactical logistic functions necessary to support the MAGTF's continued readiness and sustainability. [Ref. 9]

2. Types of MAGTFs

There are three types of MAGTFs currently utilized by the Marine Corps.

a. *Marine Expeditionary Force*

The Marine Expeditionary Force (MEF) is the principle warfighting organization for the Marine Corps and the largest of the three MAGTFs. Each MEF has approximately 46,100 Marines and Sailors within its four elements. The organizational structure for a typical MEF is depicted in Figure 2.1.

MEFs remain at their home base until called into service. At that time, they will typically deploy by echelon utilizing nearby Naval or Air Force bases. The MEF has the ability to sustain itself for approximately 60 days. After 60 days resupply will be through other U.S. Services or host nations. [Ref. 10]

There are currently three active duty MEFs within the United States Marine Corps.

- I MEF is based in southern California and Arizona and is assigned to the Commander in Chief United States Pacific Command (CINCUSUSPACOM).

- II MEF is based in North and South Carolina and is assigned to the Commander in Chief United States Atlantic Command (CINCUSACOM).

- III MEF is based in Hawaii, Okinawa, and Japan and is assigned to the Commander in Chief United States Pacific Command (CINCUSUSPACOM).

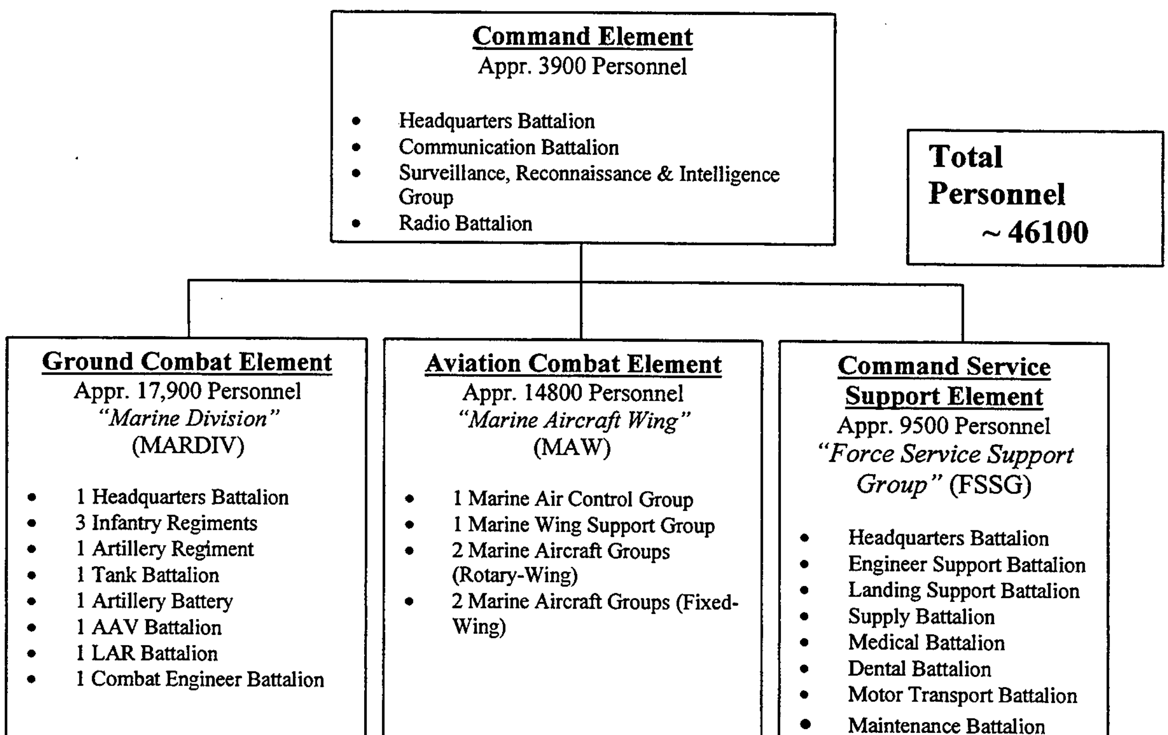

Figure 2.1. MEF Organizational Structure [Ref. 11]

b. Marine Expeditionary Unit

The Marine Expeditionary Unit (MEU) is the smallest MAGTF and is routinely forward deployed as part of an Amphibious Ready Group (ARG). Once deployed, the MEU can sustain itself ashore for a period of 15 days. Each MEU has approximately 2,200 Marines and Sailors within its four elements. [Ref. 12] The organizational structure for a typical MEU is depicted in Figure 2.2.

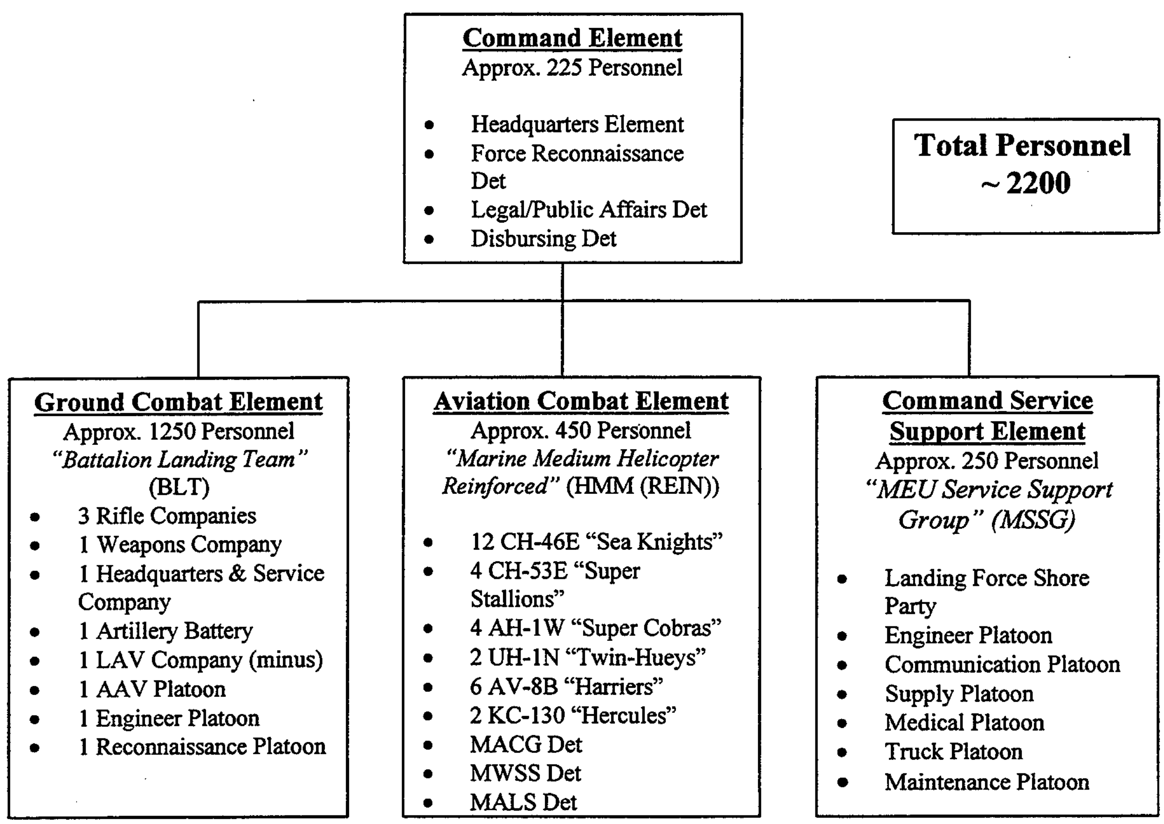

Figure 2.2. MEU Organizational Structure

There are currently seven active duty MEUs within the Marine Corps. Prior to deploying, each MEU will go through an extensive work-up and

evaluation period so they can deploy as a designated Marine Expeditionary Unit, Special Operations Capable (MEUSOC).

- The 22nd, 24th and 26th MEUs are based out of Camp Lejeune North Carolina and regularly deploy to regions bordering the Mediterranean Sea and the Atlantic Ocean.
- The 11th, 13th and 15th MEUs are based out of Camp Pendelton California and regularly deploy to regions bordering the Pacific and Indian Oceans as well as the Arabian Gulf.
- The 31st MEU is based out of Camp Smedley Butler, Okinawa, Japan and regularly deploys to regions bordering the Pacific and Indian Oceans.

c. *Special Purpose Marine Air Ground Task Force*

These MAGTFs are usually temporary in nature and formed to conduct a mission for which a MEF or a MEU is either inappropriate or unavailable. Special Purpose MAGTFs may be any size but they are usually no bigger then a MEU. Regardless of size they still will include a CE, GCE, ACE and CSSE. [Ref. 14]

C. MARINE AVIATION'S ROLE

> The primary mission of Marine Corps aviation is to participate as the air component of the MAGTF in the seizure and defense of advanced naval bases and to conduct such land operations as may be essential for the prosecution of a naval campaign. A collateral mission is to participate as an integral component of naval aviation in the execution of such other Navy functions as the fleet commanders may direct. In practice, Marine aviation assets also participate in joint operations, sometimes as part of a MAGTF or naval expeditionary force and sometimes without other Marine Corps or Navy elements.

> To accomplish its mission, Marine Corps aviation is organized, trained and equipped to provide the task-organized ACE for any size MAGTF. The ACE must be prepared to operate from both sea- and shore-based facilities in support of MAGTF expeditionary operations as well as in sustained operations ashore...[Ref. 15:p. 2-1]

1. Six Functions of Marine Aviation

When MAGTF or JTF commanders begin planning for the role that Marine Aviation will fulfill in their operation, their initial focus in on the functions the ACE can provide. [Ref. 16:p. 2-1] Marine Corps aviation assets perform the following six functions:

a. Offensive Air Support

Offensive Air Support (OAS) involves operations utilizing aerial delivered munitions against an opposing force's personnel, installations or infrastructure. OAS missions are classified into either of two categories.

- Close Air Support (CAS) – involves missions that are conducted against enemy targets within close proximity to friendly forces and thus require detailed integration.
- Deep Air Support (DAS) – involves missions that are conducted against enemy targets the are not in the immediate vicinity of friendly forces.

b. Antiair Warfare

Antiair Warfare (AAW) involves offensive and defensive measures utilized in an effort to reduce an enemy's air and missile threat to an acceptable level. [Ref. 17:p 2-3] AAW missions are classified into either of two categories:

- Offensive Antiair Warfare (OAAW) - involves those operations conducted against enemy air assets and air defense systems before they can be launched. [Ref. 18:p. 2-3]

- Air Defense - involves defensive measures designed to destroy attacking enemy aircraft and missiles. [Ref. 19:p. 2-4]

c. Assault Support

Assault Support involves using aircraft to provide tactical mobility and logistical support for the MAGTF, moving high-priority cargo and personnel within the immediate area of operations, in-flight refueling and the evacuation/ recovery of personnel and equipment. [Ref. 20:p. 2-4] Assault support missions are subdivided into seven categories.

- Combat Assault Support – involves rapidly deploying personnel and equipment to support offensive maneuver warfare, bypass obstacles or meet the enemy threat. [Ref. 21:p. 2-5]

- Aerial Delivery – involves transporting equipment or supplies to forward operating bases or remote areas in which landing sites or fields are not available. [Ref. 22:p. 2-5]

- Aerial Refueling (AR) – involves refueling airborne fixed-wing or rotary-wing aircraft by another aircraft. [Ref. 23:p. 2-5]

- Aerial Evacuation – involves transporting personnel and equipment from forward operating bases (FOB) or other remote areas to secure rear areas. [Ref. 24:p. 2-5]

- Tactical Recovery of Aircraft and Personnel (TRAP) – involves recovering downed personnel and/or equipment during a tactical situation that precludes normal Search and Rescue (SAR) operations. [Ref. 25:p. 2-5]

- Aerial Logistical Support Operations – involves using fixed-wing aircraft to deliver personnel, equipment and supplies beyond the range of helicopter or surface transportation (i.e., vehicle, ship). [Ref. 26:p. 2-5]

- Battlespace Illumination – involves the illumination of an area by either fixed-wing or rotary-wing aircraft with artificial devices such as flares or lights. [Ref. 27:p. 2-5]

d. Air Reconnaissance

Air reconnaissance involves acquiring intelligence information by employing visual observation and/or in aerial vehicles. [Ref. 28:p 2-5] There are three types of aerial reconnaissance:

- Visual Reconnaissance - involves information gathered through observation by a pilot or aircrew member. [Ref. 29:p. 2-5]

- Multisensor Imagery Reconnaissance - involves obtaining imagery from standard photographic or advanced radar and infrared cameras. [Ref. 30:p. 2-5]

- Electronic Reconnaissance – involves gathering information on enemy electromagnetic radiation by passive receivers. [Ref. 31:p. 2-6]

e. Electronic Warfare

Electronic Warfare (EW) is defined as any military action using electromagnetic and directed energy to control the electromagnetic spectrum or attack. [Ref. 32] Electronic warfare can be classified as one of three types:

- Electronic Attack (EA) – involves using electromagnetic or directed energy to attack personnel, facilities, or equipment. [Ref. 33:p. 2-6]

- Electronic Protection (EP) – involves action taken to protect friendly personnel, facilities and equipment from any effect of friendly or enemy EW employment. [Ref. 34:p. 2-6]

- Electronic Warfare Support (ES) – involves searching, intercepting, identifying and locating sources of intentionally or unintentionally radiated electromagnetic energy to recognize an immediate threat. [Ref. 35:p. 2-6]

f. Control of Aircraft and Missiles

Control of aircraft and missiles is the function that gives a commander the means to exercise their command and control over the other five functions of Marine aviation. [Ref. 36:p. 2-6] This function is further divided into two categories.

- Air Direction – is the authority to regulate air resources, including both aircraft and surface-to-air weapons, to maintain a balance between their availability and the priorities assigned to their use. [Ref. 37:p. 2-7]

- Air Control – is the authority to direct the aircraft's physical maneuver in flight or to direct an aircraft or surface-to-air weapons unit to engage a specific target. [Ref. 38:p. 2-7]

D. MARINE AIRCRAFT WING

The Marine Aircraft Wing (MAW) is the ACE of a MEF and is the smallest aviation unit that possesses the inherent capability to perform Marine Aviation's six functions. [Ref. 39:p. 5-3] Administratively, there are three active duty MAWs and one reserve. For the purpose of this study Figure 2.3 illustrates 2d MAW's organizational structure.

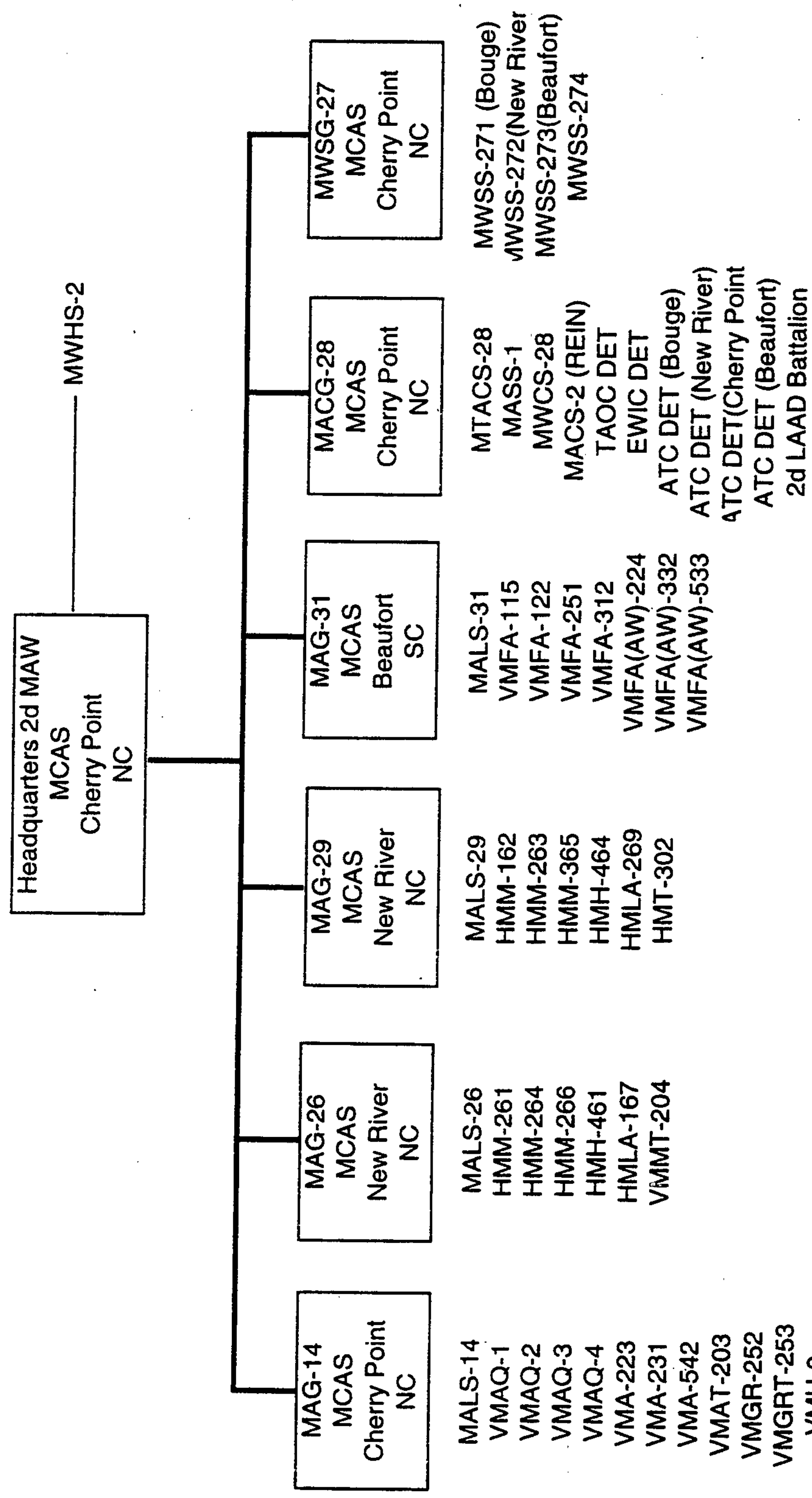

Figure 2.3. 2d Marine Aircraft Wing Organizational Structure

1. Organization

When the MAW is deployed as the ACE for a MAGTF, the MAW headquarters becomes the CE for the ACE. [Ref. 40:p. 2-7] Along with the headquarters element, the MAW's subordinate units are known as Groups. These Groups are comprised of Squadrons and are task organized on the basis of assigned missions.[2] [Ref. 41:p. 2-7]

a. Marine Air Control Group

The Marine Air Control Group (MACG) is responsible for coordinating all aspects of air command and control and air defense within the MAW. [Ref. 42:p. 2-8] Subordinate units within the MACG are:

(1) **Marine Tactical Air Command Squadron.** The Marine Tactical Air Command Squadron (MTACS) provides personnel and equipment to operate the Tactical Air Command Center (TACC). [Ref. 43:p. 2-14]

(2) **Marine Air Control Squadron.** The Marine Air Control Squadron (MACS) provides air surveillance and controls aircraft and surface-to-air weapons for AAW; it also provides continuous all-weather radar and nonradar ATC services and airspace management. [Ref. 44:p. 2-14]

[2] There is one exception. The Marine Air Control Group possesses a Low-Altitude Air Defense Battalion.

(3) **Marine Wing Communications Squadron.** The Marine Wing Communications Squadron (MWCS) provides expeditionary communications for the ACE. Although it does not perform any of Marine aviation's six functions, it supports the control of aircraft and missiles. [Ref. 45:p 2-14]

(4) **Low-Altitude Air Defense Battalion.** The Low-Altitude Air Defense Battalion (LAAD) provides close-in, surface-to-air weapons fire to defend MAGTF assets, forward combat areas, maneuver forces, vital areas, installations, and/or units engaged in special/ independent operations. [Ref. 46:p. 2-15]

b. Marine Wing Support Group

The Marine Wing Support Group (MWSG) provides all essential ground support requirements/equipment to aid designated fixed-wing or rotary-wing components of the Marine aviation combat air station, when based thereon. [Ref. 47:p. 5-38]

(1) **Marine Wing Support Squadron.** The Marine Wing Support Squadron (MWSS) provides motor transport, engineering services and organizational maintenance (to motor transport and engineering services) for either fixed-wing or rotary-wing units. [Ref. 48:p. 5-39]

c. *Marine Aircraft Groups*

The Marine Aircraft Group (MAG) is the organizational element of the MAW that possesses Marine aviation's most familiar asset, the aircraft. There are two types of MAGs, a fixed-wing and rotary-wing. Each MAG is task organized for the assigned mission to fulfill Marine Aviation's six functions. [Ref. 49:p. 2-15]

(1) **Marine Aviation Logistic Squadron.** The Marine Aviation Logistic Squadron (MALS) is the only squadron that is common across MAGs yet does not operate aircraft. They are responsible for providing intermediate-level maintenance for aircraft and equipment as well as aviation supply support. [Ref. 50:p. 2-16] Though common in name they differ because each MALS must provide the unique support required by either a fixed-wing or rotary-wing MAG.

(2) **Marine Aerial Refueler Transport Squadron.** The Marine Aerial Refueler Transport Squadrons' (VMGR) primary mission is to provide an aerial refueling service to support MAGTF air operations and assault air transport for personnel, equipment and supplies. They may also perform secondary roles as a Rapid Ground Refueler (RGR) or as a Direct Air Support Center Airborne (DASC(A)). [Ref. 51:p. 2-16] Each VMGR Squadron operates the KC-130 aircraft built by the Lockheed Martin Corporation (See Figure 2.4).

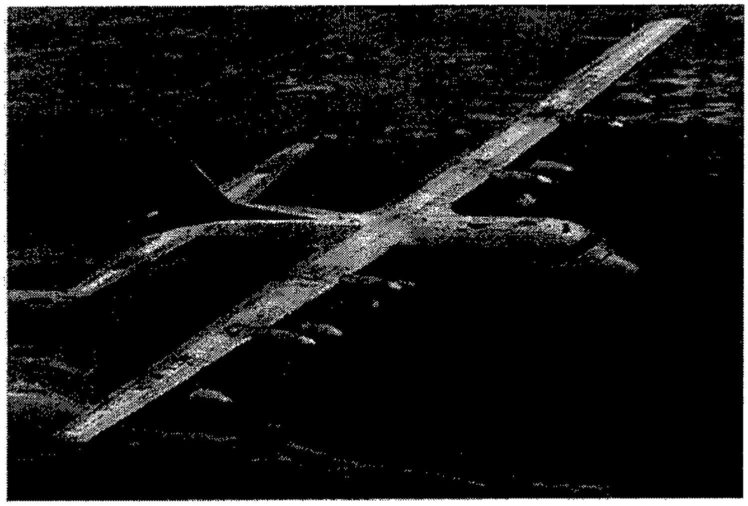

Figure 2.4. Marine KC-130 [Ref. 52]

(3) **Marine Tactical Electronic Warfare Squadron.** The Marine Tactical Electronic Warfare Squadron (VMAQ) conducts airborne EW to support MAGTF operations involving EW and air reconnaissance functions. [Ref. 53:p. 2-16] Each VMAQ Squadron operates the EA-6B "Prowler" aircraft built by the Grumman Aircraft Corporation (See Figure 2.5).

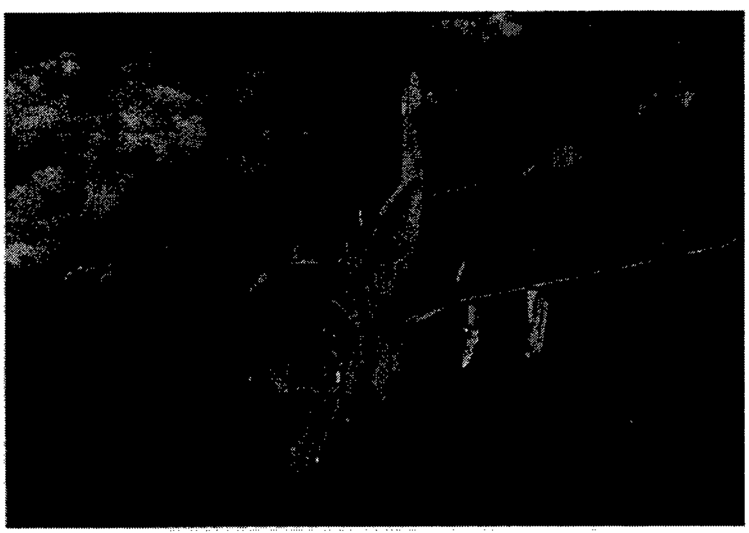

Figure 2.5. Marine EA-6B [Ref. 54]

(4) **<u>Marine Unmanned Aerial Vehicle Squadron</u>.** The Marine Unmanned Aerial Vehicle Squadron (VMU) operates and maintains a UAV system to provide the MAGTF unmanned aerial reconnaissance support. [Ref. 55:p 2-17] Each VMU Squadron operates the RQ-2 "Pioneer" UAV built by the AAI Corporation (See Figure 2.6).

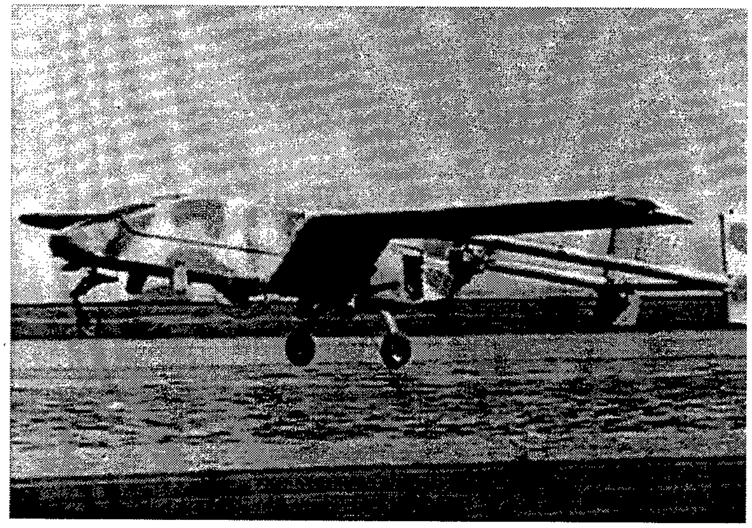

Figure 2.6. Marine RQ-2 [Ref. 56]

(5) **<u>Marine Fighter Attack Squadron</u>.** The Marine Fighter Attack Squadrons' (VMFA) primary mission is to intercept and destroy enemy aircraft under all weather conditions, and attack and destroy surface targets. [Ref. 57:p. 2-17] Each VMFA Squadron operates the single-seated F/A-18A or C "Hornet" aircraft built by the Boeing Company (See Figure 2.7).[3]

[3] The Boeing Company now owns The McDonnell Douglas Corporation the original producer of this aircraft.

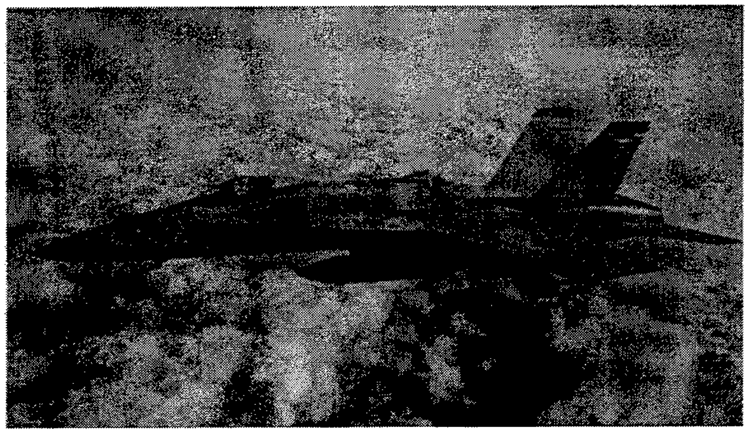

Figure 2.7. Marine F/A-18 (A/C) [Ref. 58]

(6) **Marine All-Weather Fighter Attack Squadron**. The Marine All-Weather Fighter Attack Squadrons' (VMFA(AW)) primary mission is to attack and destroy surface targets, day or night, under adverse weather conditions; conduct multisensor imagery reconnaissance; provide supporting arms coordination and intercept; and destroy enemy aircraft under all weather conditions. [Ref. 59:p. 2-17] Each VMFA(AW) Squadron operates the tandem seated F/A-18D "Hornet" aircraft built by the Boeing Company (See Figure 2.8).[3]

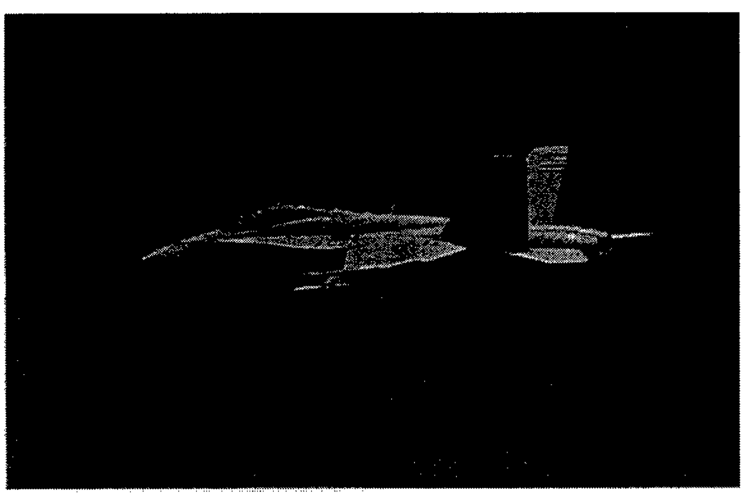

Figure 2.8. Marine F/A-18D [Ref. 60]

(7) **Marine Attack Squadron.** The Marine Attack Squadrons' (VMA) primary mission is to attack and destroy surface targets under day and night visual meteorological conditions and provide assault support escort. [Ref. 61:p. 2-18] Each VMA Squadron operates the AV-8B "Harrier" aircraft built by the Boeing Company (See Figure 2-9).[3]

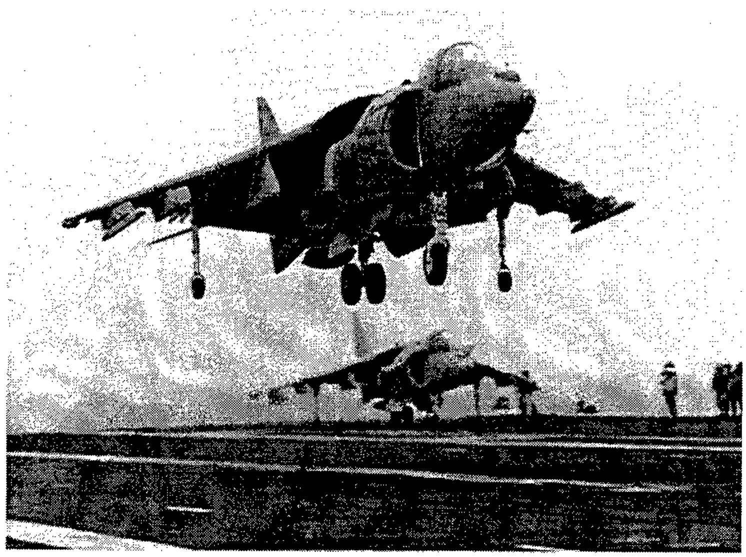

Figure 2.9. Marine AV-8B [Ref. 62]

(8) **Marine Heavy Helicopter Squadron.** The Marine Heavy Helicopter Squadrons' (HMH) primary mission is transporting heavy weapons, equipment and supplies during amphibious operations and subsequent operations ashore. [Ref. 63:p 2-18] HMH Squadrons operate either the CH-53D "Sea Stallion" (See Figure 2.10) or the CH-53E "Super Stallion" helicopters built by the Sikorsky Aircraft Corporation (See Figure 2.11).[4]

[4] Prior to the introduction of the CH-53E (16-ton payload) in 1981, the CH-53D (7-ton payload) was classified as a heavy-lift asset. They are now classified as a medium-lift asset, although the squadrons remain designated as HMHs.

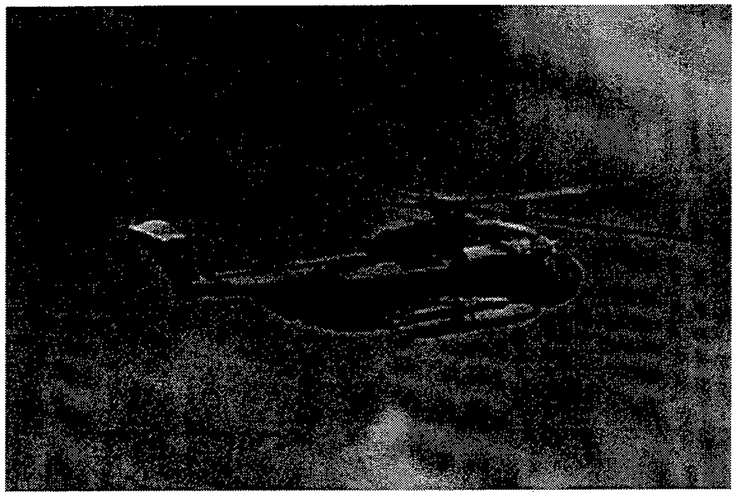

Figure 2.10. Marine CH-53D [Ref. 64]

Figure 2.11. Marine CH-53E [Ref. 65]

(9) **Marine Medium Helicopter Squadron.** The Marine Medium Helicopter Squadrons' (HMM) primary mission is to transport combat troops in the initial assault waves and follow-on stages of amphibious operations

and subsequent operations ashore. [Ref. 66:p. 2-18] HMM Squadrons operate the CH-46E "Sea Knight" helicopter built by the Boeing Company (See Figure 2.12).

Figure 2.12. Marine CH-46E [Ref. 67]

(10) **<u>Marine Light/Attack Helicopter Squadron</u>.** The Marine Light/Attack Helicopter Squadrons' (HMLA) primary mission is to provide utility helicopter support, attack helicopter fire support and fire support coordination during amphibious operations and subsequent operations ashore. [Ref. 68:p. 2-19] To fulfill this mission, the HMLAs operate two different types of helicopters. The UH-1N "Twin-huey" (See Figure 2.13) and the AH-1W "Super Cobra" (See Figure 2.14). Bell Helicopter Textron builds both helicopters.

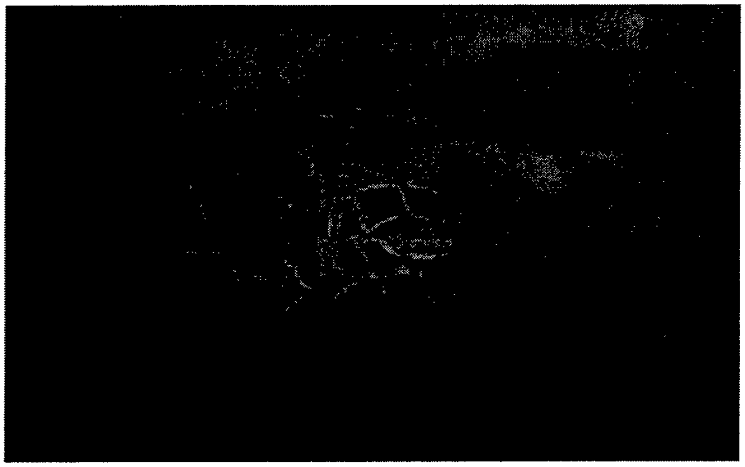

Figure 2.13. Marine UH-1N [Ref. 69]

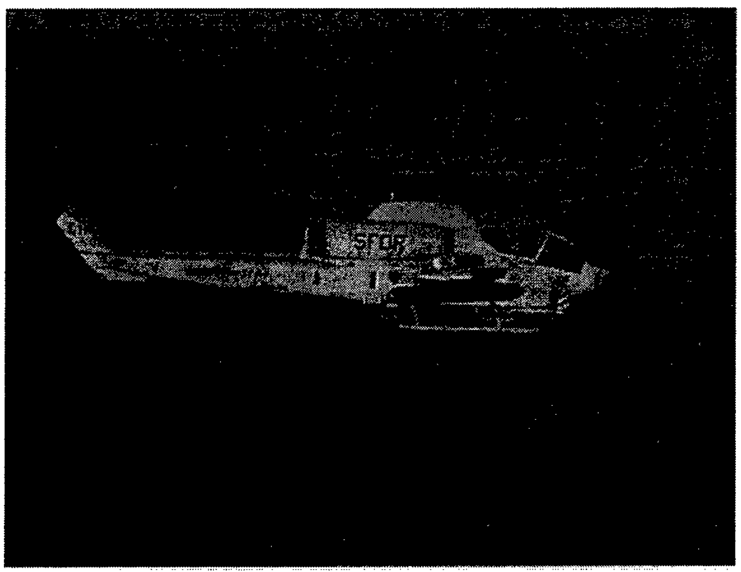

Figure 2.14. Marine AH-1W [Ref. 70]

2. Organizational Units and the Six Functions of Marine Aviation

It is essential to realize that in addition to their primary missions, many of the MAW's organizational units fulfill additional roles. Table 2.1 allows the reader to associate a specific organizational unit with an applicable Marine Aviation function.

Table 2.1. Marine Aviation Units and Functions [Ref. 71:p. 2-13]

Type of Aviation Unit	AAW	Assault Support	OAS	EW	Air Reconnnaissance	Control of Aircraft and Missles
MAW	X	X	X	X	X	X
MACG	Support	Support	Support	Support	Support	X
MTACS						TACC
MASS		DASC	DASC			
MACS	Air Control			ATC	ATC	ATC
LAAD	X					
MWCS						Communications
MAG (Fixed-Wing)	X	X	X	X	X	Support
MALS(Fixed-Wing)	Support	Support	Support	Support	Support	Support
VMGR		X			Visual	DASC(A)
VMAQ				X	X	
VMU			Support		X	
VMFA	X	Escort	X		X	
VMFA(AW)	X	Escort	X		X	FAC(A)/TAC(A)
VMA	X	Escort	X		Visual	
MAG(Rotary-Wing)	X	X	X		X	Support
MALS(Rotary-Wing)	Support	Support	Support	Support	Support	Support
HMH (CH-53D)	Self-defense	X			Visual	Airborne Control and Coordination
HMH (CH-53E)	Self-defense	X			Visual	Airborne Control and Coordination
HMM	Self-defense	X			Visual	Airborne Control and Coordination
HMLA Utility	Self-defense	X	Support		Visual	Airborne Control and Coordination
HMLA Attack	X	X	X		Visual	Airborne Control and Coordination

Legend

X = performs function
DASC, ATC, TACC, DASC(A), FAC(A) and TAC(A) = agency or group that performs function
Air control, communications, visual, escort, self-defense, airborne control and coordination, and support = roles that the unit plays within the function

E. MARINE AVIATION TRAINING AND READINESS PROGRAM

Training and Readiness Program

Marine Aviation exists in a complex, "high-risk" environment. This complexity reflects the many types of aircraft that operate within that environment. To help reduce the risk, control systems make sure that Marine Corps aircrew consistently receive the training necessary to successfully and safely operate their aircraft. The control measure most relevant to this study is the U.S. Marine Corps Aviation Training and Readiness Program.

The Training and Readiness Program standardizes training for all aviation personnel, including aircraft controllers. [Ref. 72:p. 1-3] The Training and Readiness program is coordinated through a sponsoring unit assigned by the Marine Corps Combat Development Command (MCCDC), located in Quantico, Virginia. [Ref. 73:p. D-1; Appendix D] These sponsoring units are usually the respective training unit. Changes to the program may be submitted to the sponsoring unit and reviewed at the next Training and Readiness conference. After the conference, changes are published as a Marine Corps Order.

The Training and Readiness order that specifically addresses Marine Aviation is the Marine Corps Order P3500 series. There are presently eight Volumes in this series of orders, covering all operational and support aspects of Marine Corps Aviation. [Ref. 74:p. 1-3]

Volume I summarizes the "Administrative" aspects of Marine Aviation. This volume describes the philosophy and the purpose of the Training and Readiness program as well as the rules and policies governing individual and unit training. Volumes two through eight deal with each class of aircraft (i.e., fixed-wing, rotary-wing and tilt-rotor) and Command and Control Personnel (i.e., aircraft controllers). The "core skills" are established within these seven volumes. These core skills are the individual skills that support a unit's Mission Essential Task List (METL), as prescribed by Marine Corps Manual FMFM 5-1. [Ref. 75:p. 1-3] A METL is essentially a task or mission that a unit's personnel will be required to perform in combat.

There are four tiers or phases that are measures of the aircrews' ability to perform their core skills. [Ref. 76:p. 7-3] These phases are:

- Combat Capable Phase – Basic skills acquired at a training unit before reporting to the tactical unit.
- Combat Ready Phase – Skills and qualifications that are normally obtained within the first year of assignment to the tactical unit.
- Combat Qualification Phase – Focuses on developing leadership and supervisory skills.
- Full-Combat Qualification – Qualifies most experienced personnel for positions of leadership during combat.

To advance, the aircrewman must meet the minimum training requirements (i.e., flights) established by the Training and Readiness Program. These flights are described in detail, including brief items, required maneuvers, standards and the

minimum time required. Each flight is identified by a three digit numeric code categorized by series (i.e., 100 level, 200 level, up to the 600 level) and valued at a certain percentage point. Certain higher series codes will update lower series codes. The percentage points are used to determine the aircrewman's present combat readiness level. [Ref. 77:pp. 9-4, 9-5] This value is known as the Combat Readiness Percentage (CRP).

Once an aircrewman successfully completes a flight, the Training and Readiness code is logged into their logbook and they are considered "proficient" and "current." Proficiency is the measure of achievement of a specific skill [Ref. 78:p. B-5]; currency is an additional safety measure based on the exposure frequency to a particular skill. [Ref. 79:p. B-2] When an aircrewman is proficient in a specific area, they are qualified to perform that mission outside of the training environment. To put this in perspective, it is possible to be proficient and not current but not vice-versa. As a safety feature there are "refly" periods established in the Training and Readiness program to insure that aircrew remain proficient. [Ref. 80:p. B-6]

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III. THE FUTURE AND MARINE AVIATION

A. INTRODUCTION

This chapter introduces the reader to the Marine Corps' concept for future operations, Operational Maneuver Warfare From The Sea and one of the key components to its success, the MV-22 "Osprey."

B. OPERATIONAL MANEUVER WARFARE FROM THE SEA

Operational Maneuver Warfare From The Sea (OMFTS) is the present vision statement for the Marine Corps upon entering into the 21st century. Published in January 1996, this concept has its foundation in and expands on two Navy and Marine Corps White Papers, "...From the Sea: A New Direction for the Naval Services" [Ref. 81] and "Forward...From The Sea" [Ref. 82]. Both of these documents defined the strategic concept intended to carry the Department of the Navy beyond the Cold War and into the next century. [Ref. 83:p. 32]

This strategic concept recognizes that the collapse of the Soviet Union significantly decreased the past threat of a large-scale, conventional war between two "superpowers." To be successful in the future, the United States Military will have to broaden its large-scale, conventional force-on-force strategy to encompass smaller, "pop-up" contingency operations. OMFTS is how the Marine Corps plans to adapt.

OMFTS recognizes that future trouble spots will be concentrated within the littoral areas. These littoral areas are characterized by large cites, well-populated

coasts and intersecting trade routes. Though they represent a small portion of the earth's surface, the littorals provide homes for over three-quarters of the world population, 80 percent of the "Capital" cities and nearly all the market places of international trade. [Ref. 84:p. A-1] Because of this, the Marine Corps envision themselves as America's premier immediate response force, for these future trouble spots.

OMFTS combines naval expeditionary, littoral and amphibious warfare in an effort to best exploit the sea as an avenue of approach. [Ref. 85:p. A-3] Extensive use of the sea distinguishes OMFTS from all other types of maneuver warfare. [Ref. 86:p. A-3] The sea can be used to gain advantage by allowing the free movement of friendly forces while simultaneously serving as a barrier to enemy forces. [Ref. 87:p. A-3] Using sea-based forces allows the Navy and Marine Corps to operate independent of requirements for bases, ports, airfields or over-flight rights from bordering nations. [Ref. 88:p. A-1]

OMFTS includes three supporting concepts: Ship-To-Objective Maneuver (STOM), Sustained Operations Ashore and Maritime Prepositioning-Force 2010 and Beyond. The concept relevant to this study is Ship-To-Objective Maneuver (STOM).

1. Ship-To-Objective Maneuver

> Ship-to-objective maneuver employs the concepts of maneuver warfare to project a combined arms force by air and surface means against inland objectives. Ship-to-objective maneuver takes advantage of emerging mobility and command and control systems to maneuver landing forces in their tactical array from the moment they depart the ships, replacing the ponderous ship-to-shore

movement of current amphibious warfare with true amphibious maneuver...By executing ship-to-objective maneuver, landing forces will exploit advanced technologies which permit combined arms maneuver from over-the-horizon attack positions through and across the water, air and land of littoral battlespace directly to inland objectives. [Ref. 89:p A-2 A-3]

Historically, amphibious operations have been constrained by the requirement to establish a lodgment ashore before proceeding inland towards an objective (See Figure 3.1). [Ref. 90:p. 8-2] Even after incorporating the helicopter into amphibious operations some 30 years ago, the "vertical" assault element did not fully exploit maneuver warfare potential. [Ref. 91:p. 8-2] Basically, the limited capabilities (i.e., range, payload and quantity) of vertical-lift assets has prevented full exploitation.

Figure 3.1. Historical Ship-To-Shore-To-Objective Maneuver [Ref. 92:p. A-3]

This is now changing, because of emerging technologies such as the Advance Amphibious Assault Vehicle (AAAV) and the MV-22 "Osprey." Increasing capability will allow Naval and Marine Forces to fully exploit the sea to support maneuver warfare. STOM will become a reality because Naval and Marine Forces will be able to conduct combined arms penetration and exploitation operations from over the horizon. Forces will be able to move directly to objectives ashore without stopping to seize, defend, and build-up beachheads or landing zones. (See Figure 3.2) [Ref. 93:p. A-4]

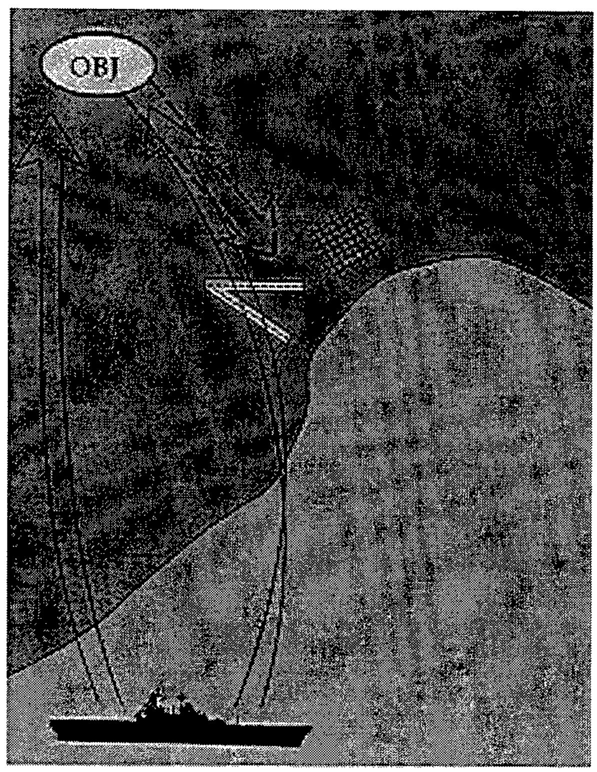

Figure 3.2. Ship-To-Objective Maneuver [Ref. 94:p. A-3]

2. The Role of Marine Aviation in OMFTS

OMFTS Seeks to extend the boundaries of maneuver warfare by viewing both land and sea as maneuver space. [Ref. 95:p. A-6] Marine Aviation adds the vertical dimension to maneuver, but more importantly it supports the MAGTF Commander's scheme of maneuver by dramatically expanding his reach throughout the battlespace. [Ref. 96:p A-6] Critical to STOM and OMFTS coming to fruition was the acquisition of the MV-22 "Osprey."

a. The MV-22 "Osprey"

The MV-22 "Osprey" is a tilt-rotor aircraft. Tilt-rotors are a unique type of aircraft that can operate within both the fixed-wing and rotary-wing flight envelopes. (See Figure 3.3) The unique design of its rotating engine nacelles and its "proprotors" are what separate the MV-22 from conventional airplanes, helicopters and experimental "tilt-wing" aircraft.[5] With the engine nacelles rotated full forward (i.e., horizontal) (See Figure 3.4), the MV-22 can fly forward as fast and efficiently as a turboprop airplane. To takeoff, hover and land vertically like a conventional helicopter (See Figure 3.5), the nacelles are rotated to a vertical position.

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[5] Tilt-wing aircraft have engines and their propellers rigidly mounted to the wing. Therefore, to convert between the horizontal and vertical positions the wing must also rotate.

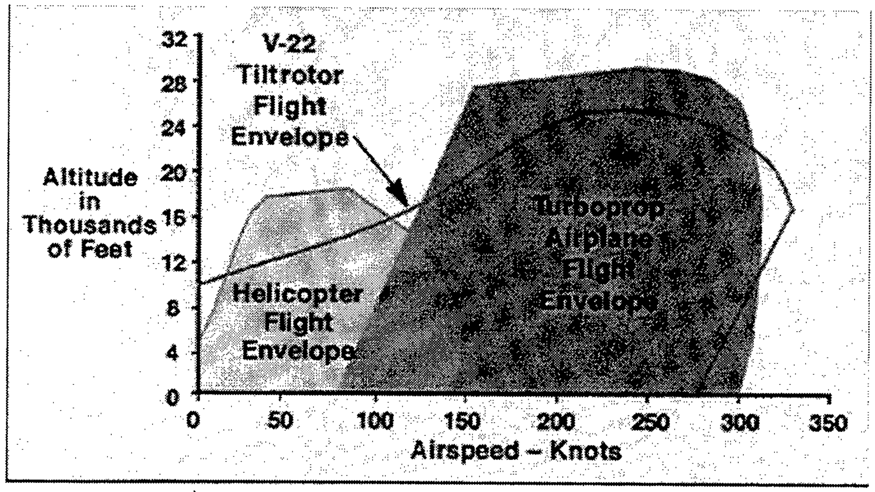

Figure 3.3. MV-22 Tilt-Rotor Operational Envelope [Ref. 97]

Figure 3.4. MV-22 "Osprey" in Airplane Mode [Ref. 98]

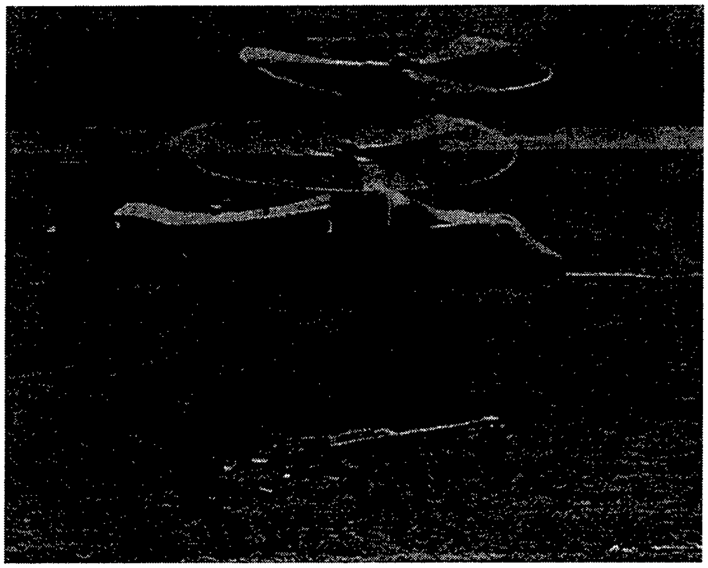

Figure 3.5. MV-22 "Osprey" in Helicopter Mode [Ref. 99]

The MV-22 "Osprey" was purchased by the Marine Corps to replace its aging fleet of medium-lift helicopters (i.e., CH-46E "Sea Knight" and CH-53D "Sea Stallion)". One of the major benefits the MV-22 offers over these helicopters is its increase in range. This single improvement provides the Marine Corps an unprecedented capability to project forces from over the horizon to inland objectives; it is key for implementing Operational Maneuver from the Sea (OMFTS). [Ref. 100]

The MV-22's superior range relative to the CH-46E and CH-53D can be attributed to two factors. The first is simply the difference in speed between a turbo-prop aircraft and a conventional helicopter. As depicted in Figure 3.3, the MV-22's airspeed in forward flight is about twice the speed of conventional helicopter.

The second reason, and most relevant to this study, is the MV-22's capability to conduct aerial refueling (See Figure 3.6). Marine Corps CH-46E and the CH-53D were not aerial refueling capable. This limited their range because these aircraft would be required to land before their fuel supply was exhausted. Possessing the capability to aerial refuel allows the MV-22 to replenish its fuel supply in flight and thus fly longer distances.

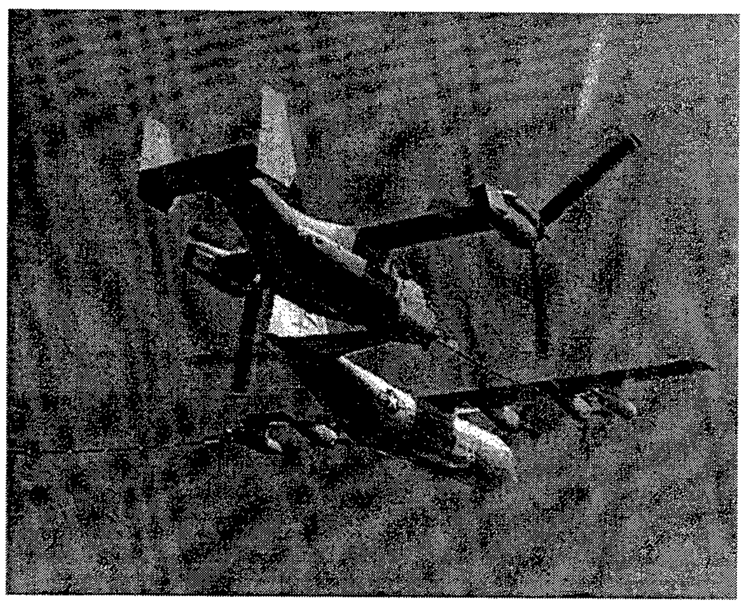

Figure 3.6. MV-22 "Osprey" Aerial Refueling from a KC-130 [Ref. 101]

A future concept, currently under development by the Boeing Company could also produce an additional benefit relevant to this study. The Medium Lift Fuel Dispensing System (MLFDS) is an internally carried refueling system that will allow the MV-22 to assume a limited "tanker" role. [Ref. 102] The system is supposed to be installed in a standard MV-22 within 90 minutes. [Ref. 103] The MLFDS comes equipped with a single hose that would be placed

through a hatch located on floor of the MV-22 and trailed behind the aircraft for aerial refueling operations. (See Figure 3.7) Additionally, this same system could be used to allow the MV-22 to perform limited Rapid Ground Refueling operations (RGR). (See Figure 3.8)

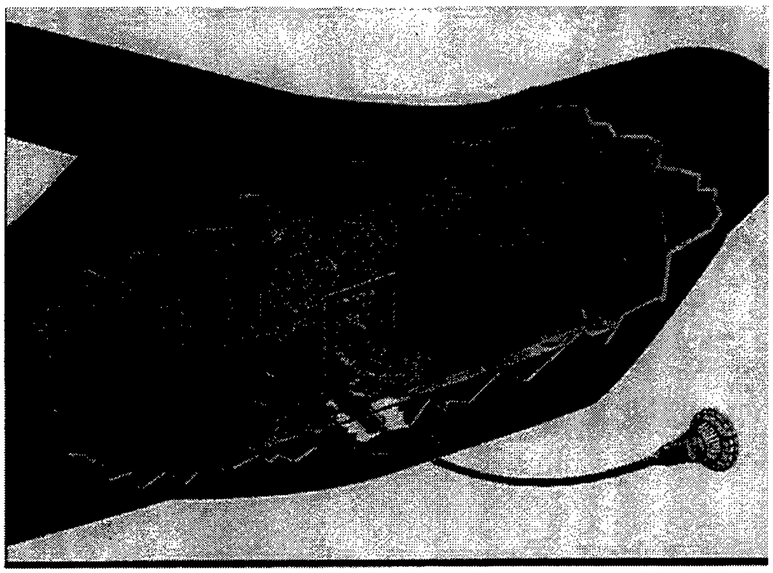

Figure 3.7. MV-22 "Osprey" with Proposed MLFDS Aerial Refueling Configuration [Ref. 104]

Figure 3.8. MV-22 "Osprey" With Proposed MLFDS Conducting Rapid Ground Refueling [Ref. 105]

IV. DEVELOPING A MODEL TO FORECAST AERIAL REFUELING TRAINING REQUIREMENTS FOR THE MV-22

A. INTRODUCTION

This chapter describes why and how the model for the future MV-22 aerial refueling training requirements was developed and presents its forecasted results.

B. IMPORTANCE OF THE MODEL

With the delivery of the first production MV-22 during May 1999, a revolutionary change for the Marine Corps as well as our sister services has come to fruition. Not only does the MV-22 offer a dramatic increase in speed and range, but it also expands an important capability to the Marine Corps Medium Lift Assault Support community: aerial refueling (AR). By expanding the AR option to our medium lift assets, Commanders will be able to move more Marines further then they could have in the past. This comprises one of the benefits that the MV-22's AR capability will offer the Marine Corps, but will there be any problems?

Since the first MV-22 Squadron has yet to go operational, the best method for answering this question is through modeling. By modeling future MV-22 aerial refueling requirements after a current aircraft, one can quantify the future requirements into relative terms. Once quantified, an informed evaluation can determine if this capability presents a problem. If a problem is identified, preemptive actions should be taken to minimize its future impact.

C. SUPPLY VERSUS DEMAND: A POTENTIAL PROBLEM

The ability to fulfill the MV-22's demand for aerial refueling is one area where a potential problem could exist. This research issue was previously noted in Captain David A. Krebs' article, "Aerial Refueling the Tiltrotar-Can It Be Done?" [Ref.106:p. X1] To describe this potential problem, Captain Krebs referred to the economic model of supply and demand. His basic implication was; if the quantity of aerial refueling tankers (supply) is held constant, and the quantity of the aerial refueling capable receivers (demand) is increased with the addition of the MV-22s, there will be a "shortage" in aerial refueling tanker capability. This assumes that Marine aviation is currently operating at or below an equilibrium point. Specifically for this study, an equilibrium point would occur only if the Marine Corps current inventory of KC-130s was capable of meeting the demand for all aerial refueling tanker support. Therefore, the only situation that would prevent a shortage would be one where excess capacity exists. Given the present status of the "aging" KC-130 fleet, this is an unlikely situation. [Ref. 107:p. X2] Thus, introducing the MV-22's demand will cause a shortage. This shortage will likely be manifested by reduced training opportunities due to insufficient tanker support.

Regarding who will bear the burden of this problem, one can argue either of two positions. Either the demanding units' training will be compromised by a tanker shortage, or the supply units will be compromised by over-working personnel and equipment as they adopt exhaustive efforts to meet the increasing

demand for aerial refueling services. A logical assumption here would be the latter. The KC-130 community will likely bare the majority of burden because of the "K" in KC-130. This "K" specifies that one of KC-130 community's primary missions is to provide an indigenous aerial refueling capability for the aviation portion of the Marine Air Ground Task Force (MAGTF). [Ref. 108:p. X3] Given the Marines' natural drive for mission accomplishment, it is safe to assume that the KC-130 community will do everything they can to satisfy this increase in demand.

D. ASSUMPTIONS AND JUSTIFICATIONS

As stated above, the MV-22's demand for aerial refueling will present a future problem that will mainly affect the KC-130 community. The task now focuses on forecasting the increase in aerial refueling demand as the MV-22 is fielded. Since the first MV-22 squadron has not yet gone operational, some assumptions must be made to characterize this demand.

The first assumption deals with the aspect of demand on which we should focus to predict the impact that the MV-22 will have on the KC-130 community. Occasionally, individuals will cite the increasing number of medium-lift <u>aerial refueling capable airframes</u> as the determining factor. [Ref. 109:p. X1] For the purpose of this study, this phrase will only refer to USMC airframes that are capable of receiving fuel. The error here is focusing on the increase in aerial refueling capable airframes in the medium lift community, vice the increase to

total USMC aerial refueling capable airframes. When one considers all Marine Corps active and reserve aerial refueling capable airframes, excluding those in AMARC at Davis Monthan AFB, the increase is about 51%. (Table 4.1)

But even then this figure does not truly reflect the impact the MV-22 will have on the KC-130 community. The error in this logic is only estimating the impact by the increase in aerial refueling capable airframes. Just because one possesses a capability does not mean that it will be exercised on a daily basis. To cite an extreme example of this statement, one only needs to look at the usage of our nuclear arsenal. to accurately quantify the impact the MV-22 will have on the KC-130 community requires looking at the aerial refueling missions required to support the MV-22 squadrons.

Table 4.1. Inventory of USMC Aircraft Capable of Receiving Aerial Refueling

USMC AR CAPABLE AIRCRAFT INVENTORY						
F/W AR capable	Active	Reserve	FRS	Other	AMARC	Total
AV-8B	131	0	11	33	5	181
EA-6B	20	0	0	0	0	20
FA-18A/C/D	185	42	37	0	0	264
FA-18B	0	0	4	0	0	4
Total F/W (AR capable)	316	42	52	33	5	469
R/W AR capable	Active	Reserve	FRS	Other	AMARC	Total
CH-53E	110	18	15	10	9	162
Total AR capable aircraft*	426	60	67	43	14	631

Table 4.1 (Continued)

	Active	Reserve	FRS	Other	AMRAC	Total
MV-22 Forecast**	235	48	40	0	0	323
% increase in Marine Corps AR capable aircraft inventory:						51.19%

* Based on Marine Corps aircraft distribution as of 30 Jun 99 from Appendix A.
** Based on "Cumulative Operating" numbers from Appendix B.

Quantifying the MV-22's impact on aerial refueling resources depends on the demand the MV-22 squadrons will place on the KC-130 community. It seems likely that their peacetime training demand will exceed any demand during actual contingency operations. There are several reasons for this presumption. The first is simply that our training requirements/evolutions far exceed our involvement in contingencies. The logic here is that every MV-22 squadron will need to train, but not every MV-22 squadron will be involved in the contingency operation during a given year. The second reason deals with the 500nm combat radius that the MV-22 will possess if it is configured with the wing overhead tanks. [Ref. 110:p. X4]

Past contingency operations have rarely exercised the aerial refueling option for assault support aircraft responding to a crisis. The most recent example (to the author's knowledge) occurred in January 1991 during "Operation Eastern Exit" in Somalia. Given the same launch point utilized by the CH-53Es, this mission could have been conducted by a wing overhead tank configured MV-22

lifted force without aerial refueling. [Ref. 111:p. X5] This is not to say that options previously rejected because of limited CH-53E support will not be exercised after fielding a tilt-rotar capable force. It merely states that, in conjunction with the focus on the littoral areas in our current doctrine "Operational Maneuver From The Sea" (OMFTS) [Ref. 112:p. X6], deployed MV-22 squadrons will be able to reach the majority of these future trouble spots without exercising their aerial refueling capability.

Considering that the MV-22's primary impact on the KC-130 community stems from peacetime aerial refueling training begs the question: how should we model the aerial refueling training requirements for MV-22 pilots? The suggestion analyzed here is to model the MV-22 aerial refueling training requirements after that of the CH-53E syllabus (simulator sorties are excluded since they do not require any external support). This seems to be a valid assumption for several reasons. First, as illustrated in Table 4.2, both communities have similar training and readiness (T&R) requirements. The "core skill" flights for a CH-53E pilot include eight flight categories that require 34 sorties totaling 57.5 flight hours. [Ref. 113:p. X7] The MV-22 syllabus has 11 flight categories that require 31 sorties for a total of 55 flight hours. [Ref. 114:p. X8] For aerial refueling

Table 4.2. MV-22 and CH-53E Core Skills and Sorties Comparison

	MV-22 T&R Code	MV-22 Hours	MV-22 Category	CH-53E T&R Code	CH-53E Hours	CH-53E Category
	210(S)	2.0	CAL	210	1.5	FORM
	211	2.0		211	2.0	
	212	2.0		220	1.5	CAL
	213(S)	2.0		221	1.5	
	214	2.0		222	1.5	
	220(S)	2.0	FORM	223	2.0	
	221	2.0		320	1.5	
	222	2.0		321	2.0	
	223(S)	2.0		230	1.5	TERF
	224	2.0		231	1.5	
	230(S)	2.0	VLAT	232	1.5	
	231	1.5		233	2.0	
	232(S)	2.0		234	2.0	
	233	1.5		330	1.5	
	234(S)	2.0		331	2.0	
	235	1.5		240	1.5	EXT
	240(S)	2.0	AG	241	1.5	
	241	1.5		242	1.5	
	242(S)	2.0		340	1.5	
	243	1.5		341	1.5	
	250(S)	2.0	EXT	342	1.5	
	251	2.0		343	2.0	
	260(S)	2.0	DM	350	2.0	DM
	330	2.0		**360**	**1.5**	**AR**
	331	1.5		**361**	**1.5**	
	270(S)	2.0	TAC	**362**	**1.5**	
	271	2.0		270(S)	1.0	CQ
	272(S)	2.0		271	1.0	
	273	2.0		272	1.0	
	340(S)	2.0		370	1.5	
	341(S)	2.0		371	1.5	
	342	3.0		372	1.5	
	343(S)	2.0		280	2.0	TAC
	344	3.0		281	2.0	
	310(S)	2.0	ANSQ	380	2.0	
	311	1.5		381	2.0	
	312(S)	2.0				
	313	1.5				
	314(S)	2.0				
	315	1.5				
	320(S)	**1.0**	AR			
	321	**1.5**				
	322(S)	**2.0**				
	323	**1.5**				
	350(S)	2.0	VIE			
	351	2.0				
	352	1.0				
	353	2.0				
	290(S)	2.0	CQ			
	291	1.0				
	292	2.0				
	300	1.5				
	301	1.5				
	302	1.5				
Total	54	100.0		35	58.5	
Simulator (S)	23	45.0		1	1.0	
Flight	**31**	**55.0**		**34**	**57.5**	

sorties, an initial "sign-off" for the CH-53E requires 3 flights (each involving a minimum of three contacts and movements to the refueling position) for a total of 4.5 flight hours. [Ref. 115:p. X7] The MV-22 syllabus requires 2 flights (each involving a minimum of five contacts and movements to the refueling position) for a total of 3.0 flight hours. [Ref. 116:p. X8] Once initial proficiency has been demonstrated, both syllabi require one day and night aerial refueling sortie to be flown every six months to maintain competency. Fixed-wing, rotary-wing and tilt-rotor aerial refueling T&R flights are compared in Table 4.3.

Another reason to model the MV-22's aerial refueling training demand after the CH-53E vice a fixed-wing aircraft deals with basic fuel legs of each airframe (excludes ferry flight configuration). Although fuel endurance is profile specific, for training evolutions both the MV-22 and the CH-53E can fly without aerial refueling for approximately four flight hours [Ref. 117:p. X9], as opposed to fixed-wing aircraft which average two flight hours or less.

After deciding how to model the MV-22's demand for aerial refueling support, the next step is to analyze the relationship between aerial refueling training requirements for an MV-22 Squadron (VMM) and a CH-53E squadron (HMH). The important relationship is the number of aerial refueling missions flown versus the number of pilots within that squadron. This analysis will quantify the MV-22 squadrons' demand for KC-130 support. The term that best

	T&R Requirements for Aerial Refueling Flights														
	AV-8B			EA-6B			FA-18A/C/D			CH-53E			MV-22		
	code	flt hrs	refly	code	flt hrs	refly	code	flt hrs	refly	code	flt hrs	refly	code	flt hrs	refly
FRS	no	no	no	AR-144	2.5	no	FIFR-115	1.5	no	no	no	no	no	no	no
	no	no	no	AR-145	1.5	no	FIFR-116(n)	1.5	no	no	no	no	no	no	no
Fleet	AR-207	1.0	12 mos	AR-206	1.7	3 mos	AR-202	1.5	6 mos	AR-360	1.5	6 mos	AR-321	1.5	6 mos
	AR-208(n)	1.0	12 mos	AR-300(n)	1.7	6 mos	AR-203(n)	1.5	12 mos	AR-361	1.5	6 mos	AR-323(n)	1.5	6 mos
				AR-400[1]	1.0	6 mos	AR-602[3]	1.5	no	AR-362(n)	1.5	6 mos	ARI-511	1.0	no
				AR-605[2]	1.5	3 mos				ARI-520	1.0	no	ARI-512(n	1.0	no
				AR-606(n)	1.5	3 mos				ARI-521(n	1.0	no			

1) low level
2) KC-135 Specific. 3 Mos refly interval function of meeting USAF predeployment 90 day currency requirements for use of a strategic tanker.
3) KC-10 or KC-135 (day or night)

Table 4.3. T&R Aerial Refueling Training Flights

describes the demand is the number of aerial refueling missions/"frags" flown to support of the VMM and VMM (Rein) squadrons.

Predicting these missions/"frags" requires assumptions on how the VMMs will operate. The first assumption addresses the operations departments' strategy in coordinating KC-130 support. Similarities between the MV-22 and CH-53E syllabi in maintaining core competencies, imply that the VMM's will at a minimum strive to maintain proficiency.

The next assumption concerns the VMM's operational schedule. Since the MV-22 is a medium lift replacement for the CH-46E and CH-53D, the assumption can be made that the MV-22 will adopt the operational schedule of a CH-46E Squadron (HMM). This is a valid assumption for the 2d Marine Aircraft Wing (MAW) and 3d Marine Aircraft Wing (MAW) since all the Marine Corps CH-53D helicopters are centrally located at Marine Corps Air Facility (MCAF) Kaneohe Bay, Hawaii, under the 1st Marine Aircraft Wing (MAW) Aviation Support Element (ASE).

If the MV-22 squadrons are going to be equated with a CH-46 squadrons, then the model must account for any differences between a core HMM squadron and a composite or HMM (Rein) squadron. To help account for any differences that could effect either types forecasted demand, a VMM squadron was equated with a HMH squadron and a VMM (Rein) squadron with that required to support a HMM (Rein) squadron's CH-53E detachment. The foundation for this assumption

rests on the basis of similar manning levels. Basically, the two HMHs minus their detachments had similar manning levels as the sample of core HMMs. Since the VMM's T/O will mirror that of the core HMM, it can be assumed that their demand will as well. The VMM (Rein) with a "T/O" of 27 pilots, will have three-times the number of pilots in the CH-53E detachment. Given these two findings, any numerical values derived from the HMHs and HMM (Rein) detachments' demand, could be converted to represent the aerial refueling demand by utilizing a 1:1 ratio for HMH to VMM and a 1:3 ratio for HMM (Rein) to VMM (Rein). Additionally, using a VMM (Rein) classification would reflect the increased "ops tempo," regimented training schedule and the predictability in scheduling aerial refueling training with dedicated KC-130 assets, that are common when a reinforced squadron becomes part of a Marine Expeditionary Unit (MEU).

E. LIMITATIONS

Given the criteria established by the previously listed assumptions, there are two important limitations concerning this model. The first limitation deals with supporting tanker aircraft. Although the MV-22 will be capable of aerial refueling from other services' tankers, such as the Air Force KC-135, the model was developed with the premise that the Marine Corps would be self-sustaining. For this study, it implies that 2d MAW will fulfill all of MAG-26 and MAG-29 demand for tanker support.

The second limitation deals with applicability of the model to all four Marine Aircraft Wings. Since the data gathered to produce the model was obtained strictly from 2d MAW squadrons, all findings will therefore be expressed in terms of their impact on 2dMAW.

F. THE MODEL

1. Data

Data for this analysis was gathered from past aerial refueling training flights conducted by several rotary wing squadrons within 2dMAW. To model the core VMM squadron, a total of 53 months worth of data was collected from HMHs-461 and 464. The VMM (Rein) squadrons were characterized using a total of 39 months worth of data collected from HMMs-263, 264 and 266 when they were last composite. Statistical analysis of the data gathered from the past flight schedules, NAVFLIRS and "core reports," was used to derive a numerical value for the eight model categories.

Before introducing the eight categories utilized by this model, a few terms should be explained. For the purpose this research, it is important to define "aerial refueling training mission" and "scheduled." For a flight to be considered an "aerial refueling training mission," one of three T&R AR codes listed in Tables 4.2 or 4.3 would have to be logged. This implies that at least one KC-130 supported the flight (KC-130s are the only aircraft that aerial refuel a CH-53E). Flights that occurred on the same day but were separated by less than five-hours

were considered one aerial refueling mission, unless otherwise annotated on the flight schedule. For an aerial refueling flight to be considered "scheduled," it would have to appear as such on the daily flight schedule. Appearing on the daily flight schedule implies that both the HMM(Rein) and HMH have coordinated this event with the supporting VMGR (KC-130 Squadron).

2. Model Categories

a. AR Missions Scheduled Per Month

This category accounted for the average number of aerial refueling training missions scheduled in a month. Since the goal of this number was to quantify the number of missions scheduled over a time period, months in which no missions were scheduled were still factored into the calculations. Values were obtained by utilizing the data listed in Appendix C.

b. AR Missions Flown Per Month

This category accounted for the average number of aerial refueling training missions flown in a month. Since the goal of this number was to quantify the number of missions flown over a time period, months that had no missions flown were still factored into the calculations. Values were obtained by utilizing the data listed in Appendix C.

c. Percentage of AR Missions Scheduled that are Flown

This category quantifies the relationship between the number of aerial refueling training missions flown versus scheduled in a month. The goal of

this number was to describe the relationship between the two categories regardless of the time period. Therefore, months that had no aerial refueling missions scheduled were not factored into the calculation. Values were obtained by utilizing the data listed in Appendix C.

d. Average Number of Pilots On-hand at Squadron per Month

This category quantifies the average number of pilots that are attached to the squadron over a time period. Values were obtained by utilizing the data listed in Appendix C.

e. Average Number of Pilots Per CH-53E

This category quantifies the average number of pilots per aircraft who logged an aerial refueling T&R code during the flight. Values were obtained by utilizing the data listed in Appendix C.

f. Average Number of AR T&R Codes Logged Per CH-53E

This category quantifies the average number of aerial refueling T&R codes logged per aircraft during an aerial refueling training flight. Values were obtained by utilizing the data listed in Appendix C.

g. Average Number of Flight Hours Logged Per CH-53E for AR Training

This category quantifies the average number of flight hours logged per aircraft in order to complete an aerial refueling training flight. Values were obtained by utilizing the data listed in Appendix C.

h. Average Number of CH-53Es per AR Mission

This category quantifies the average number of aircraft that were flown during the aerial refueling training flight. Values were obtained by utilizing the data listed in Appendix C.

3. Results

Utilizing the MV-22 fielding schedule listed in Appendix B and matching it with the appropriate category of data from Table 4.4 (i.e., HMM (Rein) or HMH), reveals the number of aerial refueling training missions that will be flown to support both 2dMAW VMM and VMM (Rein) squadrons. These results were used to produce Table 4.5. For the KC-130 community, specifically those in 2dMAW, the numbers in the "# AR msn scheduled" and "# AR msn flown" are the most important. For planning purposes, the "# AR msn scheduled" section forecasts the scheduled number of AR missions for the KC-130 community. These are the missions that appear in the monthly "frag" message. The "# AR msn flown" forecasts the number of AR missions that the KC-130 community will actually fly after accounting for cancellations due to weather and/or aircraft availability. It is important to emphasize that this is the number of missions that will be scheduled/flown, not flight hours.

Unfortunately, flight hour data was limited to the CH-53Es. However, a rough estimate based on the "Avg number of hours logged per CH-53E for AR training" section of Table 4.4 could be established. For planning purposes, a seemingly reasonable estimate assumes that a KC-130 would fly approximately

Table 4.4. Analysis Results of Historical Data

AR msns sched per mos	0.79	2.26
AR msns flown per mos	0.72	1.43
% of AR msns sched that are flown (ignores "0" msn sched mos)	90.91%	60.83%
Avg number of (CH-53E) pilots on hand at squadron per mos	9	22
Avg number of pilots per CH-53E	2.92	3.16
Avg number AR T&R codes logged per Ch-53E	3.25	3.94
Avg number of hours logged per CH-53E for AR training	2.54	3.11
Avg number of CH-53Es per AR mission	1.46	1.23

2.5 hours to support a VMM (REIN) aerial refueling training mission and 3.0 hours per VMM aerial refueling training mission. Based on this assumption, and the AR mission estimates in Table 4.5, about 464 KC-130 flight hours per year are required to support MV-22 aerial refueling training when their numbers peak in FY12 for 2dMAW.[6] Of this, about 325.5 KC-130 flight hours per year should be flown.[7]

This forecast assumes a hypothetical deployment scheduled based on the MV-22 squadrons taking over the LF6F deployment schedule by FY-05. [Ref. 118:p. X] The analysis assumes that the last two CH-46E squadrons in 2DMAW will be removed from the LF6F schedule by FY05 and that they will finally stand-down in FY09 & 10.

[6] [108 x 3.0] + [56 x 2.5] = 464

[7] [66 x 3.0] + [51 x 2.5] = 325..5

Forecasted Number of Aerial Refueling Missions Required to Support 2d MAW VMMs and VMM (Rein) Squadrons

MV-22 fielding schedule for 2d MAW

Squadron	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
VMMT-204[1]	9	12	12	12	12	14	16	17	20	19	20	19	20	29	40
VMM-264		6	9	12	12	12	12	12	12	12	12	12	12	12	12
VMM-162			6	12	12	12	12	12	12	12	12	12	12	12	12
VMM-266				6	12	12	12	12	12	12	12	12	12	12	12
VMM-261					12	12	12	12	12	12	12	12	12	12	12
VMM-365											6	12	12	12	12
VMM-263												12	12	12	12

AR msn scheduled[2]

VMM[3]	0	0	27	27	27	54	54	54	54	54	54	81	108	108	108
VMM (Rein)[4]	0	0	0	28	28	56	56	56	56	56	56	56	56	56	56
Total[5]	0	0	27	55	55	110	110	110	110	110	110	137	164	164	164

#AR msn flown[2]

VMM[6]	0	0	16	16	16	33	33	33	33	33	33	49	66	66	66
VMM (Rein)[7]	0	0	0	25	25	51	51	51	51	51	51	51	51	51	51
Total[8]	0	0	16	42	42	84	84	84	84	84	84	100	117	117	117

1) Since AR is a 300 level series flight, VMMT-204 was not factored for AR training requirements.
2) Assumes LF6F requirement completely fulfilled by MV-22 Squadrons by FY-05.
3) A core VMM is forecasted to schedule 2.26 A/R missions a month or approximately 27 per year
4) A VMM (Rein) is forcasted to schedule 0.79 A/R missions per month for every 9 pilots. Given a T/O of 27 pilots this would imply an increase of 2.37 missions per month or approximately 28 per year.
5) This is the predicted increase in the number of aerial refueling missions scheduled within 2DMAW.
6) Approximately 60.83% of the aerial refueling missions scheduled should be flown based on past HMH data.
7) Approximately 90.91% of the aerial refueling missions scheduled should be flown based on past HMM (Rein) data.
8) This is the predicted increase in the number of aerial refueling missions flown 2DMAW.

Table 4.5. Forecasted Number of Aerial Refueling Missions Required to Support 2d MAW VMM and VMM (REIN)

To forecast aerial refueling training requirements, two of the VMM squadrons were classified as reinforced and all others as core VMMs. This decision was based on the MEU deployment cycle. In any given year there is at least one MEU deployed with the Amphibious Ready Group (ARG), one "working-up" for the next deployment and one "standing-down" from the last deployment. Historical data listed in Appendix C showed that aerial refueling missions were rarely conducted during that stand-down month. This and the fact that another VMM (Rein) would not begin "working-up" with the MEU for about three to four months after their return, implied that the third MEU's squadron should be classified as a core VMM.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This chapter provides the conclusions and recommendations to the primary and subsidiary research questions, and suggests areas for further study.

B. CONCLUSIONS AND RECOMMENDATIONS

1. Primary Question

- ***How many Aerial Refueling training missions should the 2d Marine Aircraft Wing (MAW) plan to conduct to support MV-22 pilot proficiency requirements?***

Table 4.5 depicts the increase in the number of aerial refueling training missions required when the MV-22 is fielded within the 2d Marine Aircraft Wing. For example, when the MV-22 becomes fully operational within 2d MAW in FY12, there will be approximately 164 missions scheduled. Accounting for cancellations due to weather and/or aircraft availability, approximately 117 missions are forecasted to be flown.

Recommendation

For planning future requirements it seems more appropriate to use data on the missions "flown" vice "scheduled." There are two reasons for this recommendation. The "flown" data allows planners to consider many of the external variables (i.e., weather and aircraft availability) that often cancel a scheduled mission and it implies a more efficient use of assets. By using the

number of missions "scheduled," planners adopt a myopic strategy. This strategy fails to recognize other KC-130 commitments. By dedicating assets to fulfill all the "scheduled" MV-22 aerial refueling training requirements, other missions may not be accomplished.

2. Subsidiary questions

- ***Will there be a difference between the amount of Aerial Refueling training missions required to support a "core" MV-22 Squadron (VMM) and a "Reinforced" MV-22 Squadron (VMM (Rein))?***

As concluded in Chapter IV (see table 4.5), the number of aerial refueling missions required by VMM and VMM (Rein) are approximately the same. A VMM requires approximately 27 missions and a VMM (Rein) 28. However, a significant difference was discovered between the amount of missions scheduled and flown.

A VMM will schedule 27 missions in a year, but only fly 16 (60.83%). A VMM (Rein) VMM will schedule 28 missions in a year, and fly about 25 (90.91%). There is one apparent reason for this difference; the VMM (Rein) squadron has its own detachment of KC-130s. With to KC-130s in direct support of one squadron, the VMM (Rein) enjoys a significant scheduling advantage over the VMM squadron. This advantage is predictability.

Since the two KC-130s are under the MEU's operational control (OPCON) as part of their ACE, the VMM (Rein) does not have to compete with other units when requesting KC-130 support. When deployed as part of the ARG, the KC-

130's will remain in the United States on stand-by. If needed for an actual operation or training exercise (not routine training), the KC-130's will depart the United States and shore-base within range of the operation/exercise. Therefore, the VMM (Rein) will only schedule aerial refueling training missions when they know their assets are available. The VMM on other hand has to schedule their missions and then see if KC-130s can support them.

- ***How can the Marine Corps reduce the impact of the increased aerial refueling training requirements on the KC-130 community?***

To help mitigate this impact, the author offers three recommendations: a short-term, a mid-term and a long-term response.

a. Recommendation – "Short Term"

For the short-term, it would help to optimize KC-130 aerial refueling "frags" by coordinating aerial refueling training mission schedules between MAG-26 and MAG-29. To provide perspective, there were 71 Helicopter Aerial Refueling (HAR) "frags" dedicated for MAG-26 and MAG-29 squadrons (MEU squadrons included) from August 1998 to September 1999 (See Appendix D). Of these, only 5 pairs of missions occurred on the same day. This implies that roughly 92% of the MAG-26 and MAG-29 HAR missions occurred independently. This degree of independence is manageable since these "frags" only support two, eight CH-53E pilot detachments for the composite squadrons and two core HMH squadrons.

However, this percentage of independently scheduled "frags" should become less manageable when MAG-26 and MAG-29 fully field the MV-22. This degree of independence would reduce the numbers listed in Table 4.5 for FY12 on, to 152 scheduled yearly aerial refueling training "frags" of which 108 would typically be flown.[8] To put this in another perspective, given the status quo, approximately 304 annual KC-130 flight hours will be required to support 2d MAW MV-22 aerial refueling training requirements in FY12.

To suggest that the two HMHs and the six VMMs within 2dMAW will jointly coordinate their aerial refueling training missions is an example of the proverbial tail wagging the dog. The approach recommended to reduce the number independent aerial refueling training missions is blocked tanker times.

Hypothetically speaking, one 5-hour block per month could be allotted for MAG-26 and MAG-29 helicopter aerial refueling training requirements, and three 5-hour blocks for 2dMAW tilt-rotor/fixed-wing training requirements. These blocked times would be predetermined and distributed proportionately to all 2dMAW Groups to coordinate with their Squadrons. Ideally this would allow the KC-130 Squadron(s) to determine how best to manage both the increase in demand associated with the MV-22 squadrons and their own training requirements.

[8] (164 x .92) = 152 scheduled, (117 x .92) = 108 flown.

An important side-note that could make the blocked aerial refueling time periods even more critical, the MV-22's cockpit might not allow pilots to "hot-seat" in-flight.[9] [Ref. 119] In Table 3.2, both the HMH and the HMM (Rein) squadrons averaged approximately 3 pilots per aircraft during aerial refueling training. A few training flights had upwards of five and six pilots onboard to better exploit the tanker time available.

If in-flight "hot-seating" were not an option for MV-22 crews, then the aircraft would have to depart after two pilots fulfilled their training requirements. The MV-22 would have to land and switch pilot(s) before additional training could commence. A blocked time period would allow additional squadrons to conduct training while hot-seat evolutions take place on the ground. These blocked time periods could also benefit KC-130 pilot training requirements by increasing the number of tanker rendezvous conducted. They even may be a necessity when requesting Air Force tanker support.

b. Recommendation - Mid Term

A mid-term approach to reducing the impact of MV-22 aerial refueling demand would be procuring a variable speed drogue, similar to the one currently under development for the U.S Air Force's MC-130H. Presently, KC-130 squadrons operate with two drogues, a high-speed and a low-speed configuration. The low speed drogue is utilized for helicopter aerial refueling and

[9] "hot-seat" – Is a term used to describe the process of replacing one or more pilots in a cockpit with another.

has an airspeed range of approximately 105-130 knots. Fixed-wing aerial refueling is conducted with a high-speed drogue that has a range of approximately 200-250 knots. Presently the approved method for aerial refueling the MV-22 utilizes the high-speed drogue at about 210 knots. Evaluation of MV-22's low-speed aerial refueling performance is still on going. [Ref. 120]

Since flying with a "split-drogue" configuration is not a preferred option, KC-130s are usually equipped with either the high or low speed drogues. Procuring the variable speed drogue will help reduce the impact of MV-22 by permitting a KC-130 to perform a seamless transition between helicopter and fixed-wing/tilt-rotor aerial refueling training missions; this would eliminate the requirement to reconfigure the KC-130 with the appropriate drogue.

c. *Recommendation - Long Term*

An effective long-term action to mitigate the MV-22's aerial refueling training demand is to procure the Medium Lift Fuel Dispensing System (MLFDS) discussed in Chapter III. Presuming that MV-22 aerial refueling proficiency and currency requirements could be updated by tanking one MV-22 off another MV-22, this option would basically allow VMM and VMM (Rein) squadrons to conduct their own aerial refueling training. This should not completely abolish the need to aerial refuel from KC-130s, but it is another option worth obtaining and exercising.

Two scenarios in which this option would be particularly valuable include: (1) for a deployed VMM (Rein) squadron's training while their KC-130 detachment is on CONUS stand-by; (2) for the four Hawaii based VMMs, who will have to rely on transiting KC-130 squadrons/detachments to fulfill their training requirements.

It is important to emphasize that a tanker configured MV-22 can deliver about 16,000 lbs. of fuel at a 100nm radius, and 10,000 lbs. of fuel at a 300-nm radius. [Ref. 121] However, as mentioned in LtCol Timothy C. Hanifen's July 99 *Marine Corps Gazette* article, "The MV-22 Osprey, Part III: Warfighting and Related Acquisition Challenges;" this is by no means a replacement-in-kind for a KC-130 that can "give" two to three times that amount of fuel over that range. [Ref 122] What this conversion kit does provide, is an expanded capability for MAGTF Commanders to exploit in the future.

C. AREAS FOR FURTHER RESEARCH

As a result of this thesis, the author would recommend the following areas for further research:

- Apply this aerial refueling mission estimation model to the actual deployment schedule for 2d Marine Aircraft Wing MV-22 squadrons. (Requires "classified" thesis).

- Develop models for 1st, 3rd and 4th Marine Aircraft Wings.

- Quantify the total number of KC-130 flight hours required in support of MV-22 aerial refueling training missions.

- Assess the impact of the MV-22 Medium Lift Fuel Dispensing System on reducing the number of KC-130 supported Aerial Refueling training missions.

- Assess the reliability of using Air Force tanker assets for MV-22 aerial refueling training.

- Assess the impact that a single "joint" training squadron (VMMT-204) will have on pilot manning levels as the MV-22 is fielded in the Marine Corps and Air Force.

APPENDIX A. USMC AIRCRAFT DISRIBUTION AS OF 30 JUN 99

AV-8B

Count of BUNO	
UNIT	Total
AMARC	5
HMM-261	6
HMM-265	6
HMM-365	6
MALS-14	1
NADEP	26
NWTS	3
RDT&E DPRO	1
VMA-211	12
VMA-214	15
VMA-223	10
VMA-231	10
VMA-311	15
VMA-513	16
VMA-542	15
VMAT-203	11
VX-9	2
Grand Total	**160**
2dMAW	59

EA-6B

Count of BUNO	
UNIT	Total
VMAQ-1	4
VMAQ-2	5
VMAQ-3	7
VMAQ-4	4
Grand Total	**20**
2dMAW	20

F/A-18

Count of BUNO	TMS				
UNIT	FA-18A	FA-18B	FA-18C	FA-18D	Grand Total
MAG-42 DET A	8				8
MAG-46 EL TORO	11				11
MAG-49 DET A	4				4
VMFA(AW)-121				12	12
VMFA(AW)-224				12	12
VMFA(AW)-225				13	13
VMFA(AW)-242				12	12
VMFA(AW)-332				12	12
VMFA(AW)-533				12	12
VMFA-112	12				12
VMFA-115	12				12
VMFA-122	16				16
VMFA-134	1				1
VMFA-142	6				6
VMFA-212			13		13
VMFA-232			14		14
VMFA-251			12		12
VMFA-312			12		12
VMFA-314			12		12
VMFA-321	9				9
VMFA-323			12		12
VMFAT-101	5	4	9	23	41
Grand Total	**84**	**4**	**84**	**96**	**268**
2dMAW	28	0	24	36	88

CH-46E

UNIT	Total
HMM-161	12
HMM-162	12
HMM-163	13
HMM-164	19
HMM-165	12
HMM-166	12
HMM-261	15
HMM-262	14
HMM-263	13
HMM-264	12
HMM-265	12
HMM-266	12
HMM-268	12
HMM-364	12
HMM-365	12
HMM-764	8
HMM-774	9
HMT-204	6
HMX-1	7
MAG-46	7
Grand Total	**231**
2dMAW	82

CH-53E

Count of BUNO	
UNIT	Total
AMARC	9
HMH-361	19
HMH-461	15
HMH-462	15
HMH-464	15
HMH-465	10
HMH-466	20
HMH-769	7
HMH-772	8
HMM-165	4
HMM-261	4
HMM-265	4
HMM-365	4
HMT-302	15
HMX-1	6
MAG-46 DET E	3
NADEP	2
NRWATS	1
RDT&E DPRO	1
Grand Total	**162**
2dMAW	53

CH-53D

Unit	Total
AMARC	14
HMH-362	12
HMH-363	10
HMH-366	8
HMH-463	9
HMT-301	6
Grand Total	**59**
2dMAW	**0**

APPENDIX B. MV-22 FIELDING SCHEDULE

Fielding Schedule

FISCAL YEAR	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	TOTAL
MV-22 PROCUREMENT	5	7	7	10	16	20	30	30	30	30	30	30	30	30	30	25			360
MV-22 DELIVERY (CUMULATIVE STARTING)			2	9	18	28	43	63	92	123	153	183	213	243	273	303	333	360	360
CUMULATIVE DELIVERIES (MINUS ATTRITION)			2.0	9.0	17.9	27.7	42.4	62.0	90.4	120.5	149.3	177.8	206.0	234.0	261.6	289.0	316.1	339.9	
PEACETIME ATTRITION (1% OF OPERATING)			0.0	0.1	0.2	0.3	0.4	0.6	0.9	1.2	1.5	1.8	2.1	2.3	2.6	2.9	3.2	3.4	23.4
CUMULATIVE REMAINING AIRCRAFT (MINUS ATTRITION - ENDING)			1.98	8.89	17.7	27.4	42.0	61.4	89.5	119.3	147.8	176.0	204.0	231.6	259.0	286.1	313.0	336.5	336.6
CUMULATIVE OPERATING			2	9	18	27	42	61	89	119	148	176	204	232	259	286	312	323	
VMMT - 204 MAG - 26			PAX	9	12	12	12	12	14	16	17	20	19	20	19	20	29	40	
VMM - 264/MAG 26					6	9	12	12	12	12	12	12	12	12	12	12	12	12	
VMM - 162/MAG 29						6	12	12	12	12	12	12	12	12	12	12	12	12	
VMM - 266/MAG 26							6	12	12	12	12	12	12	12	12	12	12	12	
VMM - 261/MAG 29								12	12	12	12	12	12	12	12	12	12	12	
MAG - 16 3D MAW																			
VMM - WEST #1								1	12	12	12	12	12	12	12	12	12	12	
VMM - WEST #2									12	12	12	12	12	12	12	12	12	12	
VMM - WEST #3									1	12	12	12	12	12	12	12	12	12	
VMM - WEST #4										12	12	12	12	12	12	12	12	12	
III MEF / ASE K-BAY / MAG 36																			
VMM - 362 / REASSIGNED MAG 36 AFTER TRANSITION										3	12	12	12	12	12	12	12	12	
VMM - 363 / REASSIGNED MAG 36 AFTER TRANSITION											12	12	12	12	12	12	12	12	
VMM - 262 / REASSIGNED ASE K-BAY AFTER TRANSITION											5	12	12	12	12	12	12	12	

VMM - 265 / REASSIGNED ASE K-BAY AFTER TRANSITION												12	12	12	12	12	12	12	
VMM - 463												4	12	12	12	12	12	12	
MAG - 39 3D MAW																			
VMM - WEST #5													12	12	12	12	12	12	
VMM - WEST #6													6	12	12	12	12	12	
VMM - 164 (46 FRS)														12	12	12	12	12	
2D MAW																			
VMM - 365														6	12	12	12	12	
VMM - 263															12	12	12	12	
QUANTICO MCAS																			
HMX - 1									2	4	6	8	11	14	17	19	19	19	
4TH MAW																			
VMM - 774 (NORFOLK) MAG - 42															7	12	12	12	
VMM - 764 (TBD) MAG - 46																12	12	12	
VMM(H) - 769 (TBD) MAG - 46																7	12	12	
VMM(H) - 772 (WILLOW GROVE) MAG - 49																	12	12	
PIPE / RDT&E AIRCRAFT NOT FACTORED																			
360 / 30 CMC4X4OKI-HI / (A) - QDR PROCUREMENT WITH PLUS-UP OF 2 AIRCRAFT IN 1998																			
AND A THREE AIRCRAFT PLUS UP IN 2003																			

Last Updated on 3/18/99
By SRA

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APPENDIX C. HMH AND HMM (REIN) HISTORICAL DATA FOR TABLE 4.4

HMH - DATA

Column1	Column2
Flown	Sched
0	0
0	0
0	0
0	1
0	1
0	2
0	0
0	0
0	0
0	0
0	1
0	0
0	2
0	2
0	3
1	2
1	1
1	2
1	2
1	2
1	2
1	2
1	1
1	1
1	2
1	1
1	4
1	2
1	2
1	2
1	1
1	1
1	2
1	3
1	2
2	2
2	8
2	3
2	3
2	2
2	2
3	3
3	4
3	4
3	5
3	3
3	3
3	4
4	5
4	4
5	6
5	5
5	5

"AR msns sched per mos"

Scheduled	Monthly	Yearly
	Column2	
Mean	2.264151	27.16981
Standard Error	0.235079	
Median	2	
Mode	2	
Standard Deviation	1.711398	
Sample Variance	2.928882	
Kurtosis	1.302569	
Skewness	0.958207	
Range	8	
Minimum	0	
Maximum	8	
Sum	120	
Count	53	

"AR msns flown per mos"

Flown	Monthly	Yearly
	Column1	
Mean	1.433962	17.20755
Standard Error	0.195206	
Median	1	
Mode	1	
Standard Deviation	1.421124	
Sample Variance	2.019594	
Kurtosis	0.410326	
Skewness	1.058024	
Range	5	
Minimum	0	
Maximum	5	
Sum	76	
Count	53	

HMH - Data

Column1 Flown	Column2 Sched
0	1
0	1
0	2
0	1
0	2
0	2
0	3
1	2
1	1
1	2
1	2
1	2
0	2
0	2
0	1
1	1
1	2
1	1
1	4
1	2
1	2
1	2
1	1
1	1
1	2
1	3
1	2
2	2
2	8
2	3
2	3
2	2
2	2
3	3
3	4
3	4
3	5
3	3
3	3
3	4
4	5
4	4
5	6
5	5
5	5

Column1	
Mean	1.622222
Standard Error	0.216232
Median	1
Mode	1
Standard Deviation	1.450531
Sample Variance	2.10404
Kurtosis	0.029819
Skewness	0.891123
Range	5
Minimum	0
Maximum	5
Sum	73
Count	45

Column2	
Mean	2.666667
Standard Error	0.229184
Median	2
Mode	2
Standard Deviation	1.537412
Sample Variance	2.363636
Kurtosis	2.099545
Skewness	1.339576
Range	7
Minimum	1
Maximum	8
Sum	120
Count	45

"% of AR msns sched that are flown (ignores "0" msn sched mos)"*

* Calculated by dividing "Mean" column 1 by "Mean" column 2.

60.83%

HMH - Data

# of Pilots
19
23
23
24
24
15
13
13
15
25
25
25
24
24
25
27
20
21
21
21
24
16
20
22
24
25
28
28
20
20
20
20
20
26
26
27
16
17
18
22
23
24
24
26
24
24

"Avg number of (CH-53E) pilots on hand at squadron per mos"

	Column1
Mean	21.97826
Standard Error	0.569337
Median	23
Mode	24
Standard Deviation	3.861428
Sample Variance	14.91063
Kurtosis	-0.170442
Skewness	-0.692108
Range	15
Minimum	13
Maximum	28
Sum	1011
Count	46

HMH - Data

Column 1	Column 2	Column 3
# Pilots	flown hrs	Logged T&R codes
2	2.0	1
2	2.3	2
2	2.6	2
2	2.8	2
2	2.5	2
2	1.4	2
2	0.9	2
2	2.5	2
2	2.3	2
2	1.5	2
2	1.3	1
2	3.5	2
3	2.3	3
3	1.8	
3	2.3	3
3	4.4	6
3	4.0	3
3	3.9	3
3	3.7	3
3	2.2	3
3	3.0	3
3	3.0	3
3	2.8	4
3	3.0	3
3	4.0	5
3	4.0	7
3	3.3	3
3	3.8	3
3	2.1	3
3	2.2	3
3	2.8	3
3	2.1	3
3	3.7	5
3	4.5	6
3	4	6
3	2.4	4
4	3.0	4
4	4.5	8
4	4.4	8
4	5.1	3
4	4.0	
4	3.0	8
4	4.3	5
4	2.3	4
4	4	8
5	3.0	6
5	4.8	9
5	3.6	5
5	3.5	4
6	5	7

"Avg # pilots per CH-53E"

Column1	
Mean	3.16
Standard Error	0.135104
Median	3
Mode	3
Standard Deviation	0.955329
Sample Variance	0.912653
Kurtosis	0.604853
Skewness	0.837034
Range	4
Minimum	2
Maximum	6
Sum	158
Count	50

" Avg number of hours logged per CH-53E foe AR training"

Column2	
Mean	3.108
Standard Error	0.14512
Median	3
Mode	4
Standard Deviation	1.026156
Sample Variance	1.052996
Kurtosis	-0.761038
Skewness	0.000859
Range	4.2
Minimum	0.9
Maximum	5.1
Sum	155.4
Count	50

"Avg number of AR T&R codes logged per CH-53E"

Column3	
Mean	3.9375
Standard Error	0.29835
Median	3
Mode	3
Standard Deviation	2.067028
Sample Variance	4.272606
Kurtosis	-0.152987
Skewness	0.901642
Range	8
Minimum	1
Maximum	9
Sum	189
Count	48

HMH - Data

Column 1 # FLTS	Column 2 #A/C
1	1
1	1
1	1
1	2
1	1
1	1
1	2
1	1
1	2
1	1
1	1
1	1
1	1
1	1
1	1
1	1
1	1
1	1
1	1
1	1
1	1
2	2
2	2
2	2
2	2
2	2
2	2
2	2
3	6
3	3
3	3
3	5
3	4
3	3
3	3
4	4
5	7
5	7
5	8
5	7

Flts per month

	Column1
Mean	2
Standard Error	0.208782
Median	1
Mode	1
Standard Deviation	1.320451
Sample Variance	1.74359
Kurtosis	0.374994
Skewness	1.195764
Range	4
Minimum	1
Maximum	5
Sum	80
Count	40

A/C per A/R mission

	Column 2
Mean	2.45
Standard Error	0.318148
Median	2
Mode	1
Standard Deviation	2.012143
Sample Variance	4.048718
Kurtosis	1.366332
Skewness	1.547851
Range	7
Minimum	1
Maximum	8
Sum	98
Count	40

"Avg number of CH-53E's per AR mission"* 1.225

* Calculated by dividing "Mean" column 2 by "Mean" column 1.

HMM (REIN) - Data

Column 1 # Pilots per A/C	Column 2 # T&R codes logged per A/C	Column 3 # of hours logged per A/C
2	1	1.0
2	1	1.0
2	2	2.2
2	2	1.3
3	3	3.0
3	3	3.0
3	6	3.0
3	3	2.0
3	3	2.5
4	3	4.0
4	4	3.5
4	8	4.0

"Avg # pilots per CH-53E"

Column1	
Mean	2.916667
Standard Error	0.228908
Median	3
Mode	3
Standard Deviation	0.792961
Sample Variance	0.628788
Kurtosis	-1.26079
Skewness	0.161056
Range	2
Minimum	2
Maximum	4
Sum	35
Count	12

Column2	
Mean	3.25
Standard Error	0.578988
Median	3
Mode	3
Standard Deviation	2.005674
Sample Variance	4.022727
Kurtosis	2.030553
Skewness	1.374068
Range	7
Minimum	1
Maximum	8
Sum	39
Count	12

"Avg number of hours logged per CH-53E for AR training"

Column3	
Mean	2.541667
Standard Error	0.307842
Median	2.75
Mode	3
Standard Deviation	1.066394
Sample Variance	1.137197
Kurtosis	-1.13381
Skewness	-0.18617
Range	3
Minimum	1
Maximum	4
Sum	30.5
Count	12

HMM (REIN) - Data

Column 1 Scheduled	Column 2 Flown
0	1
0	0
0	0
3	2
2	1
2	0
2	3
0	0
1	0
0	0
0	0
1	0
0	0
0	1
	1
	2
	1
	0
	0
	0
	0
	0
	5
	0
	1
	0
	0
	0
	3
	2
	2
	2
	0
	1
	0
	0
	0
	0
	0

"AR msns sched per mos"

Scheduled	Monthly	Yearly
Column1		
Mean	0.785714	9.428571
Standard Error	0.280865	
Median	0	
Mode	0	
Standard Deviation	1.050902	
Sample Variance	1.104396	
Kurtosis	-0.46809	
Skewness	0.956297	
Range	3	
Minimum	0	
Maximum	3	
Sum	11	
Count	14	

"AR msns flown per mos"

Scheduled	Monthly	Yearly
Column2		
Mean	0.717949	8.615385
Standard Error	0.183491	
Median	0	
Mode	0	
Standard Deviation	1.145902	
Sample Variance	1.31309	
Kurtosis	4.083277	
Skewness	1.918984	
Range	5	
Minimum	0	
Maximum	5	
Sum	28	
Count	39	

HMM-266 Flown	Scheduled
0	0
0	0
0	0
3	3
2	2
2	2
2	2
0	0
1	1
0	0
0	0
0	1
0	0
0	0
• 10	11

"% of AR msns sched that are flown (ignores "0" msn sched mos)"*

* Calculated by dividing HMM-266 "Flown" Data by "Scheduled" Data, because of data available limitation.

90.91%

"Avg number of (CH-53E) pilots on hand at squadron per mos"**

** HMM (REIN) will always be staffed at a "T/O" of nine CH-53E pilots for MEU(SOC) deployments.

9

HMM (REIN) - Data

Column 1 # A/R Msns flown	Column 2 # A/C per Msn
1	1
1	2
1	1
1	2
1	1
1	1
1	2
2	3
2	4
2	3
2	2
2	2
3	5
3	4
5	8
total	total
28	41

"Avg number of CH-53E's per AR mission"* 1.464286

* Calculated by dividing total Column 2 by total Column 1.

APPENDIX D. SCHEDULED 2D MAW AERIAL REFUELING MISSIONS AUG 98 – SEP 99

		Helo AR					dMA	Helo AR			Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Aug-98	4						1				
	5										
	6		1								
	10					1					
	11					1	1				
	12										
	18					1					
	19		1				1				
	20					1	1				
	21						1				
	22						1				
	23						1				
	25							1			
	26		1*								
		0	2	0	0	4	7	1	0	0	0

		Helo AR					dMA	Helo AR			Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Sep-98	1						1				
	2	1					1				
	3	1	1								
	8						1				
	9	1					1				
	10	1	1								
	15						1	1			1
	16						1	1			
	17		1				1				
	18						1				
	24		1								
		4	4	0	0	0	8	2	0	0	1

		Helo AR					dMA	Helo AR			Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Oct-98	13	1									
	14				1						
	15				1						
	16										1
	17										1
	19						1				
	20						1				
	21						1	1			
	22						1	1			
	27	1									
	28						1				
		2	0	0	2	0	4	2	0	0	2

		Helo AR					dMA	Helo AR			Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Nov-98	2										1
	3										1
	4		1								1
	5										2
	9										1
	10										1
	11										1
	12										1
	13										1
	14										1
	15										
	16						1				
	17						1				
	18	1									
	19		1								
	20						1				
	22										
	23						1				
	24						2				
	25						2				
	30					1					
		1	2	0	0	1	8	0	0	0	11

		Helo AR					dMA	Helo AR			Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Dec-98	1					1					
	2					1					
	4		1								
	5										
	6										1
	7										1
	8										1
	9										1
	10						1				2
	11						1				1
	12										1
	15	1					1				
	16		1				1				
	17		1				1				
	20										1
	21										1
	22		1								1
	23										1
	24										1
		1	4	0	0	2	5	0	0	0	13

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Jan-99	6						1				1
	7						1				1
	8										1
	9										1
	10	1									
	11	1					1				
	12	1					1				
	13	1									
	19						1				1
	20						1				1
	21						1				1
	22										1
	23										1
	24										1
	25										2
	26										3
	27										3
	28										2
	29										2
	30										2
	31										1
		4	0	0	0	0	7	0	0	0	25

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Feb-99	1						1				
	2						1				
	4		1								
	5						1				
	6						1				
	7						1				
	8						1				
	9						1				
	10						1				
	11						1				
		0	1	0	0	0	9	0	0	0	0

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Mar-99	3						1				
	4						2				
	5						2				
	6						2				
	7						2				1
	8						1				1
	10	1									1
	11										1
	12										1
	13										1
	14										1
	15										1
	16										1
	17	1						1			1
	18							1			1
	19							1			1
	20							1			1
	21										1
	22										1
	23										1
	24	1									1
	25										1
	26										1
	27										1
		3	0	0	0	0	10	4	0	0	20

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Apr-99	1										1
	2										1
	3										1
	5								1		
	7					1					
	8					1					
	11										1
	12										1
	13								1		1
	14										1
	15										1
	16						1				1
	17						1				1
	18								1		1
	19								1		1
	20								1		1
	21								1		1
	22								1		1
	23								1		1
	24								1		1
	25										1
	26										1
	27										1
	28										1
	29										1
	30										1
		0	0	0	0	2	2	0	9	0	23

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
May-99	3						1				
	4						1				
	5						1				
	6			1							
	9								1		
	10						1				1
	11						1				1
	12										1
	13		1	1							1
	14										1
	15										1
	16										1
	17								1		1
	18						1			1	1
	19						1			1	1
	20						1			1	1
	21						1			1	1
	22						1				1
	23						1				1
	24						1				1
	25		1				1				1
	26						1				1
	27						1				1
	28						1				1
	29										1
	30										1
	31										1
		0	2	2	0	0	16	0	2	4	22

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Jun-99	7										1
	8		1								1
	20										1
	21		1								
	22		1								
	23		1								
		0	4	0	0	0	0	0	0	0	3

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Jul-99	8		1								
	15		1								
	21		1								
	22		1								
	23		1								
		0	5	0	0	0	0	0	0	0	0

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Aug-99	3			1							
	4			1							
	10	1									
	18	1									
	19				1						
	20						2				
	21						2				
	24			1							
	25	1		1							
	26	1	1								
	31		1								1
		4	2	4	1	0	4	0	0	0	1

				Helo AR			dMA		Helo AR		Other
Month	Day	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Sep-99	1			1			1				1
	2			1			1				
	3						1				
	5										1
	6								1		2
	7								1		2
	8								1		2
	9	1							1		2
	10						1				2
	11						1				2
	12						1				
	13						2				
	14						1			1	1
	15	1								1	1
	16									1	1
	17						1				
	19										1
	20	1									1
	21	1					1				1
	22						1	1			1
	23	1						1			1
	24						1				1
	25								1		1
	26								1		1
	27								1		1
	28								1		1
	29	1							1		1
	30										1
		6	0	2	0	0	13	2	9	3	29

			Helo AR			dMA		Helo AR		Other
	HMH-46	HMH-46	22 MEU	24 MEU	26 MEU	F/W	USN	USA	USAF	Tanker Msn
Totals:	25	26	8	3	9	93	11	20	7	150

Total 2dMAW Helo A/R	71
Total 2dMAW F/W A/R	93
Total Joint Helo A/R	38
Total Other Tanker Msns	150

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